ACCEPTANCE REQUIREMENTS AND HOME ENERGY RATING SYSTEMS (HERS) FIELD VERIFICATION AND DIAGNOSTIC TESTING REGULATIONS

for the

2005 BUILDING ENERGY EFFICIENCY STANDARDS FOR NONRESIDENTIAL HGH-RISE RESIDENTIAL and HOTELS/MOTELS BUILDINGS

CALIFORNIA ENERGY COMMISSION

STANDARDS/REGULATIONS

Effective October 1, 2005

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Arnold Schwarzenegger, *Governor*

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Note: The fallowing are excerpts from the Nonresidential Alternative Calculation Method Approval Manual P400-03-004F.

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Overview

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The Building Energy Efficiency Standards for nonresidential, high-rise residential and hotel/motel buildings (Sections 121 (c) 5, 121 (f), 122 (h), 125 (b), 125 (c), 125 (d), and 131 (f) for newly constructed buildings, 149 (a) additions, and 149 (b) 1 A and 149 (b) 2 A for alterations to existing buildings) contain provisions for acceptance requirements for specific features or components of the building. Section 10-103 (b) requires that a Certificate of Acceptance be filed with and approved by, the building department for these features or components prior to receiving a final occupancy permit. Section 10-103 (a) 2 B requires that the acceptance requirements for each feature or component shall be specified on the plans and specifications and that record drawings be provided to the building owner.

The purpose of this section is to make easily available Appendix NJ of the Nonresidential Alternative Calculation Methods Approval Manual, including all subsections, so that building officials and all building professionals who have a role in successful compliance for features and components that have acceptance requirements can easily locate the requirements. Appendix NJ contains subsections that document acceptance testing protocols that must be used to comply with the acceptance requirements. Also, the forms that are used for documenting compliance with the acceptance requirements are included here.

Readers should recognize that the Nonresidential Compliance Manual provides further clarification of the acceptance requirements. The Nonresidential Compliance Manual is on the Commission's website at:
http://www.energy.ca.gov/2005publications/CEC-400-2005-006/CEC-400-2005-006-CMF.PDF.

Acceptance Requirements for Nonresidential Buildings

Note: the fallowing pages are excerpts from the *Nonresidential Alternative Calculation Method Approval Manual, P400-03-004F*.

NONRESIDENTIAL ACM MANUAL APPENDIX NJ

Appendix NJ - Acceptance Requirements for Nonresidential Buildings

NJ.1 Purpose and Scope

ACM NJ defines acceptance procedures that must be completed before credit can be claimed for certain compliance measures. The procedures apply to nonresidential, high-rise residential and hotel/motel buildings as defined by the California Energy Commission's Energy Efficiency Standards for Nonresidential Buildings.

NJ.2 Introduction

Acceptance Requirements are defined as the application of targeted inspection checks and functional and performance testing conducted to determine whether specific building components, equipment, systems, and interfaces between systems conform to the criteria set forth in the Standards and to related construction documents (plans or specifications). Acceptance Requirements can effectively improve code compliance and help determine whether equipment meets operational goals and whether it should be adjusted to increase efficiency and effectiveness.

This section describes the process for completing the Acceptance Requirements. The steps include the following:

- Document plans showing sensor locations, devices, control sequences and notes,
- Review the installation, perform acceptance tests and document results, and
- Document the operating and maintenance information, complete installation certificate and indicate test results on the Certificate of Acceptance, and submit the Certificate to the building department prior to receive a final occupancy permit.

Acceptance testing is not intended to take the place of commissioning or test and balance procedures that a building owner might incorporate into a building project. It is an adjunct process focusing only on demonstrating compliance with the Standards.

The installing contractor, engineer of record or owners agent shall be responsible for reviewing the plans and specifications to assure they conform to the Acceptance Requirements. This is typically done prior to signing a Certificate of Compliance.

The installing contractor, engineer of record or owners agent shall be responsible for providing all necessary instrumentation, measurement and monitoring, and undertaking all required acceptance requirement procedures. They shall be responsible for correcting all performance deficiencies and again implementing the acceptance requirement procedures until all specified systems and equipment are performing in accordance with the Standards.

The installing contractor, engineer of record or owners agent shall be responsible for documenting the results of the acceptance requirement procedures including paper and electronic copies of all measurement and monitoring results. They shall be responsible for performing data

analysis, calculation of performance indices and crosschecking results with the requirements of the Standard. They shall be responsible for issuing a Certificate of Acceptance. Building departments shall not release a final Certificate of Occupancy until a Certificate of Acceptance is submitted that demonstrates that the specified systems and equipment have been shown to be performing in accordance with the Standards. The installing contractor, engineer of record or owners agent upon completion of undertaking all required acceptance requirement procedures shall record their State of California Contractor's License number or their State of California Professional Registration License Number on each Certificate of Acceptance that they issue.

NJ.3 Outdoor Air

NJ.3.1 Variable Air Volume Systems Outdoor Air Acceptance

NJ.3.1.1 Construction Inspection

Prior to Acceptance Testing, verify and document the following:

- Outside air flow station is calibrated *OR* a calibration curve of outside air vs. outside air damper position, inlet vane signal, or VFD signal was completed during system TAB procedures.

NJ.3.1.2 Equipment Testing

Step 1: If the system has an outdoor air economizer, force the economizer high limit to disable economizer control (e.g. for a fixed drybulb high limit, lower the setpoint below the current outdoor air temperature)

Step 2: Drive all VAV boxes to the greater of the minimum airflow or 30% of the total design airflow. Verify and document the following:

- Measured outside airflow CFM corresponds to no less than 90% of the total value found on the Standards Mechanical Plan Check document MECH-3, Column H or Column I (which ever is greater).
- System operation stabilizes within 15 minutes after test procedures are initiated (no hunting).

Step 3: Drive all VAV boxes to achieve design airflow. Verify and document the following:

- Measured outside airflow CFM corresponds to no less than 90% of the total value found on Standards Mechanical Plan Check document MECH-3, Column H or Column I (which ever is greater).
- System operation stabilizes within 15 minutes after test procedures are initiated (no hunting).

NJ.3.2 Constant Volume System Outdoor Air Acceptance

NJ.3.2.1 Construction Inspection

Prior to Acceptance Testing, verify and document the following:

- The system has a fixed or motorized minimum outdoor air damper, or an economizer capable of maintaining a minimum outdoor air damper position.

NJ.3.2.2 Equipment Testing

Step 1: If the system has an outdoor air economizer, force the economizer high limit to disable economizer control (e.g. for a fixed drybulb high limit, lower the setpoint below the current outdoor air temperature)

- Measured outside airflow CFM with damper at minimum position corresponds to no less than 90% of the total value found on the Standards Mechanical Plan Check document MECH-3, Column H or Column I (which ever is greater).

NJ.4 Packaged HVAC Systems

Acceptance requirements apply only to constant volume, direct expansion (DX) packaged systems with gas furnaces or heat pumps.

NJ.4.1 Constant Volume Packaged HVAC Systems Acceptance

NJ.4.1.1 Construction Inspection

Prior to Performance Testing, verify and document the following:

- Thermostat is located within the zone that the HVAC system serves.
- Space temperature thermostat is factory-calibrated (proof required) or field-calibrated.
- Appropriate temperature deadband has been programmed.
- Appropriate occupied, unoccupied, and holiday schedules have been programmed.
- Appropriate pre-occupancy purge has been programmed per Standards Section 121(c)2.
- Economizer lockout control sensor, if applicable, is factory-calibrated (proof required) or field-calibrated and setpoint properly set (refer to the *ECONOMIZERS* acceptance requirements section for detail).
- Demand control ventilation controller, if applicable, is factory-calibrated (proof required) or field-calibrated and setpoint properly set (refer to the *DEMAND CONTROL VENTILATION* acceptance requirements section for detail).

NJ.4.1.2 Equipment Testing

Step 1: Simulate heating load during occupied condition (e.g. by setting time schedule to include actual time and placing thermostat heating setpoint above actual temperature). Verify and document the following:

- Supply fan operates continually during occupied condition.
- Gas-fired furnace, heat pump or electric heater, if applicable, stages on.
- No cooling is provided by the unit.
- Outside air damper is open to the minimum position.

Step 2: Simulate "no-load" during occupied condition (e.g. by setting time schedule to include actual time and placing thermostat heating setpoints below actual temperature and cooling setpoint below actual temperature). Verify and document the following:

- Supply fan operates continually during occupied condition.

- Neither heating or cooling is provided by the unit.
- Outside air damper is open to the minimum position.

Step 3: If there is an economizer, simulate cooling load and economizer operation, if applicable, during occupied condition (e.g. by setting time schedule to include actual time and placing thermostat cooling setpoint below actual temperature). Verify and document the following:

- Supply fan operates continually during occupied condition.
- Refer to the *ECONOMIZERS* acceptance requirements section for testing protocols.
- No heating is provided by the unit.

Step 4: If there is no economizer, simulate cooling load during occupied condition (e.g. by setting time schedule to include actual time and placing thermostat cooling setpoint below actual temperature). Verify and document the following:

- Supply fan operates continually during occupied condition.
- Compressor(s) stage on.
- No heating is provided by the unit.
- Outside air damper is open to the minimum position.

Step 5: Change the time schedule force the unit into unoccupied mode. Verify and document the following:

- Supply fan turns off.
- Outside air damper closes completely.

Step 6: Simulate heating load during setback conditions (e.g. by setting time schedule to exclude actual time and placing thermostat setback heating setpoint above actual temperature). Verify and document the following:

- Supply fan cycles on.
- Gas-fired furnace, heat pump or electric heater, if applicable, stages on.
- No cooling is provided by the unit.
- Supply fan cycles off when heating equipment is disabled.

Step 7: If there is an economizer, simulate cooling load and economizer operation, if applicable, during unoccupied condition (e.g. by setting time schedule to exclude actual time and placing thermostat setup cooling setpoint below actual temperature). Verify and document the following:

- Supply fan cycles on.
- Refer to the *ECONOMIZERS* acceptance requirements section for testing protocols.
- Supply fan cycles off when call for cooling is satisfied (simulated by lowering the thermostat setpoint to below actual temperature).
- Outside air damper closes when unit cycles off.

Step 8: If there is no economizer, simulate cooling load during setup condition (e.g. by setting time schedule to exclude actual time and placing thermostat setup cooling setpoint above actual temperature). Verify and document the following:

- Supply fan cycles on.
- Compressor(s) stage on to satisfy cooling space temperature setpoint.
- No heating is provided by the unit.
- Supply fan cycles off when cooling equipment is disabled.

Step 9: Simulate manual override during unoccupied condition (e.g. by setting time schedule to exclude actual time or by pressing override button). Verify and document the following:

- System reverts to "occupied" mode and operates as described above to satisfy a heating, cooling, or no load condition.
- System turns off when manual override time period expires.

NJ.5. Air Distribution Systems

Acceptance requirements apply only to systems covered by Section 144(k).

NJ.5.1 Air Distribution Acceptance

NJ.5.1.1 Construction Inspection

Prior to Performance Testing, verify and document the following:

- Drawbands are either stainless steel worm-drive hose clamps or UV-resistant nylon duct ties.
- Flexible ducts are not constricted in any way (for example pressing against immovable objects or squeezed through openings).
- Duct leakage tests shall be performed before access to ductwork and associated connections are blocked by permanently installed construction material.
- Joints and seams are not sealed with a cloth back rubber adhesive tape unless used in combination with mastic and drawbands.
- Duct R-values are verified.
- Insulation is protected from damage and suitable for outdoor service if applicable.

NJ.5.1.2 Equipment Testing

Step 1: Perform duct leakage test per 2005 Nonresidential ACM Approved Manual, Appendix NG, Section 4.3.8.2. Certify the following:

- Duct leakage conforms to the requirements of Section 144(k).

Step 2: Obtain HERS Rater field verification as required by Chapter 7 and Appendix NG.

NJ.6. Lighting Control Systems

Lighting control testing is performed on:

- Manual Daylighting Controls.
- Automatic Daylighting Controls.
- Occupancy Sensors.
- Automatic Time-switch Control.

NJ.6.1 Automatic Daylighting Controls Acceptance

NJ.6.1.1 Construction Inspection

Prior to Performance Testing, verify and document the following:

- All control devices (photocells) have been properly located, factory-calibrated (proof required) or field-calibrated and set for appropriate set points and threshold light levels.
- Installer has provided documentation of setpoints, setting and programming for each device.
- Luminaires located in either a horizontal daylit area(s) or a vertical daylit area(s) are powered by a separate lighting circuit from non-daylit areas.

NJ.6.1.2 Equipment Testing

Continuous Dimming Control Systems

Step 1: Simulate bright conditions for a continuous dimming control system. Verify and document the following:

- Lighting power reduction is at least 65% under fully dimmed conditions.
- At least one control step reduces the lighting power by at least 30%.
- Only luminaires in daylit zone are affected by daylight control.
- Automatic daylight control system reduces the amount of light delivered to the space uniformly.
- Dimming control system provides reduced flicker operation over the entire operating range per Standards Section 119(e)2.
- Lumen measurements in the space, location of measurements and specific device settings, program settings and other measurements are documented.

Step 2: Simulate dark conditions for a continuous dimming control system. Verify and document the following:

- Automatic daylight control system increases the amount of light delivered to the space uniformly.
- Dimming control system provides reduced flicker operation over the entire operating range per Standards Section 119(e)2.

- Lumen measurements in the space, location of measurements and specific device settings, program settings and other measurements are documented.

Stepped Dimming Control Systems

Step 1: Simulate bright conditions for a stepped dimming control system. Verify and document the following:

- Lighting power reduction is at least 50% under fully dimmed conditions.
- Only luminaires in daylit zone are affected by daylight control.
- Automatic daylight control system reduces the amount of light delivered to the space relatively uniformly as per Section 131(b).
- Automatic daylight control system reduces the amount of light delivered to the space per manufacturer's specifications for power level verses light level.
- Minimum time delay between step changes is 3 minutes to prevent short cycling.
- Lumen measurements in the space, location of measurements and specific device settings, program settings and other measurements are documented.

Step 2: Simulate dark conditions for a stepped dimming control system. Verify and document the following:

- Automatic daylight control system increases the amount of light delivered to the space per manufacturer's specifications for power level verses light level.
- Stepped dimming control system provides reduced flicker over the entire operating range per Standards Section 119(e)2.
- Minimum time delay between step changes is 3 minutes to prevent short cycling.
- Lumen measurements in the space, location of measurements and specific device settings, program settings and other measurements are documented.

Stepped Switching Control Systems

Step 1: Simulate bright conditions for a stepped switching control system. Verify and document the following:

- Lighting power reduction is at least 50% under fully switched conditions per Standards Section 119(e)1.
- Only luminaires in daylit zone are affected by daylight control.
- Automatic daylight control system reduces the amount of light delivered to the space relatively uniformly as per Section 131(b).
- Automatic daylight control system reduces the amount of light delivered to the space per manufacturer's specifications for power level verses light level.
- Single- or multiple-stepped switching controls provide a dead band of at least three minutes between switching thresholds to prevent short cycling.
- Lumen measurements in the space, location of measurements and specific device settings, program settings and other measurements are documented.

Step 2: Simulate dark conditions for a stepped switching control system. Verify and document the following:

- Automatic daylight control system increases the amount of light delivered to the space per manufacturer's specifications for power level verses light level.
- Single- or multiple-stepped switching controls provide a dead band of at least three minutes between switching thresholds to prevent short cycling.
- Lumen measurements in the space, location of measurements and specific device settings, program settings and other measurements are documented.

NJ.6.2 Occupancy Sensor Acceptance

NJ.6.2.1 Construction Inspection

Prior to Performance Testing, verify and document the following:

- Occupancy sensor has been located to minimize false signals.
- Occupancy sensors do not encounter any obstructions that could adversely affect desired performance.
- Ultrasound occupancy sensors do not emit audible sound.

NJ.6.2.2 Equipment Testing

Step 1: For a representative sample of building spaces, simulate an unoccupied condition. Verify and document the following:

- Lights controlled by occupancy sensors turn off within a maximum of 30 minutes from the start of an unoccupied condition per Standard Section 119(d).
- The occupant sensor does not trigger a false "on" from movement in an area adjacent to the controlled space or from HVAC operation.
- Signal sensitivity is adequate to achieve desired control.

Step 2: For a representative sample of building spaces, simulate an occupied condition. Verify and document the following:

- Status indicator or annunciator operates correctly.
- Lights controlled by occupancy sensors turn on immediately upon an occupied condition, *OR s*ensor indicates space is "occupied" and lights are turned on manually (automatic OFF and manual ON control strategy).

NJ.6.3 Manual Daylighting Controls Acceptance

NJ.6.3.1 Construction Inspection

Prior to Performance Testing, verify and document the following:

- If dimming ballasts are specified for light fixtures within the daylit area, make sure they meet all the Standards requirements, including "reduced flicker operation" for manual dimming control systems.

NJ.6.3.2 Equipment Testing

Step 1: Perform manual switching control. Verify and document the following:

- Manual switching or dimming achieves a lighting power reduction of at least 50%.
- The amount of light delivered to the space is uniformly reduced.

NJ.6.4 Automatic Time Switch Control Acceptance

NJ.6.4.1 Construction Inspection

Prior to Performance Testing, verify and document the following:

- Automatic time switch control is programmed with acceptable weekday, weekend, and holiday (if applicable) schedules.
- Document for the owner automatic time switch programming including weekday, weekend, holiday schedules as well as all set-up and preference program settings.
- Verify the correct time and date is properly set in the time switch.
- Verify the battery is installed and energized.
- Override time limit is no more than 2 hours.

NJ.6.4.2 Equipment Testing

Step 1: Simulate occupied condition. Verify and document the following:

- All lights can be turned on and off by their respective area control switch.
- Verify the switch only operates lighting in the ceiling-height partitioned area in which the switch is located.

Step 2: Simulate unoccupied condition. Verify and document the following:

- All non-exempt lighting turn off per Section 131 (d)1.
- Manual override switch allows only the lights in the selected ceiling height partitioned space where the override switch is located, to turn on or remain on until the next scheduled shut off occurs.
- All non-exempt lighting turns off.

NJ.7. Air Economizer Controls

Economizer testing is performed on all built-up systems and on packaged systems per Standards Section 144 (e)1. Air economizers installed by the HVAC system manufacturer and certified to the commission as being factory calibrated and tested do not require field testing.

NJ.7.1 Economizer Acceptance

NJ.7.1.1 Construction Inspection

Prior to Performance Testing, verify and document the following:

- Economizer lockout setpoint complies with Table 144-C per Standards Section 144 (e) 3.

- System controls are wired correctly to ensure economizer is fully integrated (i.e. economizer will operate when mechanical cooling is enabled).
- Economizer lockout control sensor location is adequate (open to air but not exposed to direct sunlight nor in an enclosure; away from sources of building exhaust; at least 25 feet away from cooling towers).
- Relief fan or return fan (if applicable) operates as necessary when the economizer is enabled to control building pressure.
- If no relief fan or return fan is installed, barometric relief dampers are installed to relieve building pressure when the economizer is operating.

NJ.7.1.2 Equipment Testing

Step 1: Simulate a cooling load and enable the economizer by adjusting the lockout control (fixed or differential dry-bulb or enthalpy sensor depending on system type) setpoint. Verify and document the following:

- Economizer damper modulates opens per Standards Section 144 (e)1A to maximum position to satisfy cooling space temperature setpoint.
- Return air damper modulates closed and is completely closed when economizer damper is 100% open.
- Economizer damper is 100% open before mechanical cooling is enabled.
- Relief fan or return fan (if applicable) is operating or barometric relief dampers freely swing open.
- Mechanical cooling is only enabled if cooling space temperature setpoint is not met with economizer at 100% open.
- Doors are not pushed ajar from over pressurization.

Step 2: Continue from Step 1 and disable the economizer by adjusting the lockout control (fixed or differential dry-bulb or enthalpy sensor depending on system type) setpoint. Verify and document the following:

- Economizer damper closes to minimum position.
- Return air damper opens to normal operating position.
- Relief fan (if applicable) shuts off or barometric relief dampers close. Return fan (if applicable) may still operate even when economizer is disabled.
- Mechanical cooling remains enabled until cooling space temperature setpoint is met.

NJ.8. Demand Control Ventilation (DCV) Systems

Demand control ventilation is tested on package systems per Standards Section 121 (c)3.

NJ.8.1 Packaged Systems DCV Acceptance

NJ.8.1.1 Construction Inspection

Prior to Performance Testing, verify and document the following:

- Carbon dioxide control sensor is factory calibrated (proof required) or field-calibrated with an accuracy of no less than 75 ppm.
- The sensor is located in the room between 1ft and 6 ft above the floor.
- System controls are wired correctly to ensure proper control of outdoor air damper system.

NJ.8.1.2 Equipment Testing

Step 1: Simulate a high CO2 load and enable the demand control ventilation by adjusting the demand control ventilation controller setpoint below ambient CO2 levels. Verify and document the following:

- Outdoor air damper modulates opens per Standards to maximum position to satisfy outdoor air requirements specified in Section 121(c).

Step 2: Continue from Step 1 and disable demand control ventilation by adjusting the demand control ventilation controller setpoint above ambient CO2 levels. Verify and document the following:

- Outdoor air damper closes to minimum position.

NJ.9. Variable Frequency Drive Systems

NJ.9.1 Supply Fan Variable Flow Controls

NJ.9.1.1 Construction Inspection

Prior to Performance Testing, verify and document the following:

- Discharge static pressure sensor is factory calibrated (proof required) or field-calibrated with secondary source.
- Disable discharge static pressure reset sequences to prevent unwanted interaction while performing tests.

NJ.9.1.2 Equipment Testing

Step 1: Drive all VAV boxes to achieve design airflow. Verify and document the following:

- Witness proper response from supply fan (e.g. VFD ramps up to full speed; inlet vanes open full).
- Supply fan maintains discharge static pressure within +/-10% of setpoint.
- Measured maximum airflow corresponds to design and/or TAB report within +/-10%.
- System operation stabilizes within a reasonable amount of time after test procedures are initiated (no hunting).

Step 2: Drive all VAV boxes to minimum flow or to achieve 30% total design airflow whichever is larger. Verify and document the following:

- Witness proper response from supply fan (VFD slows fan speed; inlet vanes close).
- Supply fan maintains discharge static pressure within +/-10% of setpoint.
- System operation stabilizes within a reasonable amount of time after test procedures are initiated (no hunting).

NJ.10. Hydronic System Controls Acceptance

Hydronic controls Acceptance Testing will be performed on:

- Variable Flow Controls
- Automatic Isolation Controls
- Supply Water Temperature Reset Controls
- Water-loop Heat Pump Controls
- Variable Frequency Drive Control

NJ.10.1 Variable Flow Controls

NJ.10.1.1 Construction Inspection

Prior to Acceptance Testing, verify and document the following:

- Valve and piping arrangements were installed per the design drawings to achieve flow reduction requirements.
- Installed valve and hydronic connection pressure ratings meet.
- Installed valve actuator torque characteristics meet specifications.

NJ.10.1.2 Equipment Testing

Step 1: Open all control valves. Verify and document the following:

- System operation achieves design conditions.

Step 2: Initiate closure of control valves. Verify and document the following:

- The design pump flow control strategy achieves flow reduction requirements.
- Ensure all valves operate correctly against the minimum flow system pressure condition.

NJ.10.2 Automatic Isolation Controls

NJ.10.2.1 Construction Inspection

Prior to Acceptance Testing, verify and document the following:

- Valve and piping arrangements were installed per the design drawings to achieve equipment isolation requirements.
- Installed valve and hydronic connection pressure ratings meet specifications.
- Installed valve actuator torque characteristics meet specifications.

NJ.10.2.2 Equipment Testing

Step 1: Open all control valves. Verify and document the following:

- System operation achieves design conditions.

Step 2: Initiate shut-down sequence on individual pieces of equipment. Verify and document the following:

- The design control strategy meets isolation requirements automatically upon equipment shut-down.
- Ensure all valves operate correctly at shut-off system pressure conditions.

NJ.10.3 Supply Water Temperature Reset Controls

NJ.10.3.1 Construction Inspection

Prior to Acceptance Testing, verify and document the following:

- All sensors have been calibrated.
- Sensor locations are adequate to achieve accurate measurements.
- Installed sensors comply with specifications.

NJ.10.3.2 Equipment Testing

Step 1: Manually change design control variable to maximum setpoint. Verify and document the following:

- Chilled or hot water temperature setpoint is reset to appropriate value.
- Actual supply temperature changes to meet setpoint.

Step 2: Manually change design control variable to minimum setpoint. Verify and document the following:

- Chilled or hot water temperature setpoint is reset to appropriate value.
- Actual supply temperature changes to meet setpoint.

NJ.10.4 Water-loop Heat Pump Controls

NJ.10.4.1 Construction Inspection

Prior to Acceptance Testing, verify and document the following:

- Valves were installed per the design drawings to achieve equipment isolation requirements.
- Installed valve and hydronic connection pressure ratings meet specifications.
- Installed valve actuator torque characteristics meet specifications.
- All sensor locations comply with design drawings.
- All sensors are calibrated.
- VFD minimum speed setpoint exceeds motor manufacturer's requirements.
- VFD minimum speed setpoint should not be set below the pumping energy curve inflection point (i.e. combination of pump-motor-VFD efficiency at reduced load may cause power requirements to increase upon further reduction in load).

NJ.10.4.2 Equipment Testing

Step 1: Open all control valves. Verify and document the following:

- System operation achieves design conditions +/- 5%.
- VFD operates at 100% speed at full flow conditions.

Step 2: Initiate shut-down sequence on each individual heat pumps. Verify and document the following:

- Isolation valves close automatically upon unit shut-down.
- Ensure all valves operate correctly at shut-off system pressure conditions.
- Witness proper response from VFD (speed decreases as valves close).
- System operation stabilizes within 5 minutes after test procedures are initiated (no hunting).

Step 3: Adjust system operation to achieve 50% flow. Verify and document the following:

- VFD input power less than 30% of design.

Step 4: Adjust system operation to achieve a flow rate that would result in the VFD operating below minimum speed setpoint. Verify and document the following:

- Ensure VFD maintains minimum speed setpoint regardless of system flow operating point.

NJ.10.5 Variable Frequency Drive Controls

NJ.10.5.1 Construction Inspection

Prior to Acceptance Testing, verify and document the following:

- All valves, sensors, and equipment were installed per the design drawings.
- All installed valves, sensors, and equipment meet specifications.
- All sensors are calibrated.
- VFD minimum speed setpoint exceeds motor manufacturer's requirements.
- VFD minimum speed setpoint should not be set below the pumping energy curve inflection point (i.e. combination of pump-motor-VFD efficiency characteristics at reduced load may cause input power to increase upon further reduction in load).

NJ.10.5.2 Equipment Testing

Step 1: Open all control valves. Verify and document the following:

- System operation achieves design conditions +/- 5%.
- VFD operates at 100% speed at full flow conditions.

Step 2: Modulate control valves closed. Verify and document the following:

- Ensure all valves operate correctly at system operating pressure conditions.
- Witness proper response from VFD (speed decreases as valves close).
- System operation stabilizes within 5 minutes after test procedures are initiated (no hunting).

Step 3: Adjust system operation to achieve 50% flow. Verify and document the following:

- VFD input power less than 30% of design.

Step 4: Adjust system operation to achieve a flow rate that would result in the VFD operating below minimum speed setpoint. Verify and document the following:

- Ensure VFD maintains minimum speed setpoint regardless of system flow operating point.

COMPLIANCE FORMS

MECHANICAL

- MECH-1-A Certificate of Acceptance
- MECH-2-A Ventilation Systems – Variable and Constant Volume
- MECH-3-A Packaged HVAC Systems
- MECH-4-A Economizer Acceptance
- MECH-5-A Air Distribution Acceptance
- MECH-6-A Demand Control Ventilation
- MECH-7-A Supply Fan VFD
- MECH-8-A Hydronic Systems Control

LIGHTING

- LTG-1-A Certificate of Acceptance
- LTG-2-A Lighting Controls
- LTG-3-A Automatic Daylighting

2005 CERTIFICATE OF ACCEPTANCE (Part 1 of 3) MECH-1-A

PROJECT NAME		DATE
PROJECT ADDRESS		
TESTING AUTHORITY	TELEPHONE	Checked by/Date Enforcement Agency Use

GENERAL INFORMATION

DATE OF BLDG. PERMIT	PERMIT #	BLDG. CONDITIONED FLOOR AREA	CLIMATE ZONE
BUILDING TYPE	☐ NONRESIDENTIAL	☐ HIGH RISE RESIDENTIAL	☐ HOTEL/MOTEL GUEST ROOM
PHASE OF CONSTRUCTION	☐ NEW CONSTRUCTION	☐ ADDITION ☐ ALTERATION	☐ UNCONDITIONED

STATEMENT OF ACCEPTANCE

This Certificate of Acceptance summarizes the results of the acceptance tests related to building mechanical requirements per Title 24, Part 6. (Sections 10-103.b, 121.f, 122.h, 125.a, 125.b, 125.c, 125.c.5, 125.d)

Please check one:

☐ I hereby affirm that I am eligible under the provisions of Division 3 of the Business and Professions Code to sign this document as the person responsible for it's preparation; and that I am licensed in the State of California as a civil engineer or mechanical engineer, or I am a licensed architect.

☐ I affirm that I am eligible under the exemption to Division 3 of the Business and Professions Code by Section 5537.2 or 6737.3 to sign this document as the person responsible for its preparation; and that I am a licensed contractor performing this work.

☐ I affirm that I am eligible under the exemption to Division 3 of the business and Professions Code to sign this document because it pertains to a structure or type of work described pursuant to Business and Professions Code sections 5537, 5538, and 6737.1.

(These sections of the Business and Professions Code are printed in full in the Nonresidential Manual.)

TESTING AUTHORITY - NAME	SIGNATURE	DATE	LIC.#

INSTRUCTIONS TO APPLICANT

For Detailed instructions on the use of this and all Energy efficiency Standards acceptance forms, please refer to the Nonresidential Manual published by the California Energy Commission.

Part 1 of 3 - Statement of Acceptance
Part 2 of 3 - Summary of Acceptance Tests
Part 3 of 3 - Summary of Acceptance Testing Results

2005 CERTIFICATE OF ACCEPTANCE (Part 2 of 3) MECH-1-A

PROJECT NAME	DATE

SUMMARY OF ACCEPTANCE TESTS

SYSTEM ACCEPTANCE DOCUMENT(Form __ of __)	TESTING AUTHORITY	DATE OF TEST	PASS / FAIL	NOTES Bldg. Dept.

NOTE: Use additional sheets as necessary

2005 CERTIFICATE OF ACCEPTANCE (Part 3 of 3) MECH-1-A

PROJECT NAME	DATE

SUMMARY OF ACCEPTANCE TESTING RESULTS

Certified	N / A	Testing Authority Certifies That:
Air Distribution Systems		
☐	☐	The air distribution ducts and plenums meet the requirements of Section 124(a) through Section 124(g).
☐	☐	The air distribution ducts meet the requirements of Section 144(k).
Variable Air Volume Systems		
☐	☐	The fans meet the requirements of Section 144.c.2.
☐	☐	The variable air volume systems installed to comply Section 141 with individual VAV fans of motors 10 horsepower or larger shall comply with Section 144.c.2.B.
Hydronic System Controls		
☐	☐	The fans meet the requirements of Section 144(i).
☐	☐	Hydronic systems installed to comply to Section 141 shall be certified to meet requirements of each of Sections 144.i.1 through 144.i.6.
Economizer		
☐	☐	The economizers meet the requirements of Section 144.e1, 2, and 3.

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Ventilation System Acceptance Document — MECH-2-A

NJ.3.1, NJ.3.2 — Form __ of __

PROJECT NAME		DATE
PROJECT ADDRESS		
TESTING AUTHORITY	TELEPHONE	
VENTILATION SYSTEM NAME / DESIGNATION		_____ Checked by/Date Enforcement Agency Use

Intent: Verify measured outside airflow CFM is within ± 10% of the total required outside airflow value found in the Standards Mechanical Plan (MECH-3, Column I), per 121(f).

Construction Inspection

1 Instrumentation to perform test includes, but not limited to:
   a. Watch
   b. Means to measure airflow (hot wire anemometer or pitot tube)

2 Check one of the following:

☐ Variable Air Volume (VAV) - Check as appropriate:
   a. Sensor used to control outdoor air flow must have calibration certificate or be field calibrated
      ☐ Calibration certificate (attach calibration certification)
      ☐ Field calibration (attach results)

☐ Constant Air Volume (CAV) - Check as appropriate:
   ☐ System is designed to provide a fixed minimum OSA when the unit is on

Certification Statement: I certify that all statements are true on this MECH-2-A form including the PASS/FAIL Evaluation. I affirm I am eligible to sign this form under the provisions described in the Statement of Acceptance on form MECH-1-A

Name: _____

Company: _____

Signature: _____ Date: _____

License: _____ Expires: _____

A. Equipment Testing	CAV	VAV

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Ventilation System Acceptance Document — MECH-2-A

NJ.3.1, NJ.3.2 — Form __ of __

PROJECT NAME	DATE

a.		Constant or Variable Air Volume (CAV or VAV) - check appropriate column		
b.		Verify unit is not in economizer mode during test - check appropriate column		
Step 1: CAV and VAV testing at full supply airflow				
	1	Drive boxes open (check)		
	2	Measured outdoor airflow (cfm)		
	3	Required outdoor airflow (cfm) *(from MECH-3, column I)*		
	4	Time for outside air damper to stabilize after VAV boxes open (minutes)		
	5	Return to initial conditions (check)		
Step 2: VAV testing at reduced supply airflow				
	1	Drive boxes to minimum (check)		
	2	Measured outdoor airflow (cfm)		
	3	Required outdoor airflow (cfm) *(from MECH-3, column I)*		
	4	Time for outside air damper to stabilize after VAV boxes open (minutes)		
	5	Return to initial conditions (check)		

B. Testing Calculations & Results	**CAV**	**VAV**
Step 1: % Outdoor Air = Measured outside air /Required outside air (Step1:2/Step1:3)	%	%
90%< %Outdoor Air > 110%	Y / N	Y / N
Outside air damper position stabilizes within 15 minutes (Step 1:4 < 15 minutes)	Y / N	Y / N
Step 2: % Outdoor Air = Measured outside air /Required outside air (Step2:2/Step2:3)		
90%< %Outdoor Air > 110%		Y / N
Outside air damper position stabilizes within 15 minutes (Step 2:4 < 15 minutes)		Y / N

Note: Shaded areas do not apply for particular test procedure

C. PASS / FAIL Evaluation (check one):	
☐	PASS: All **Construction Inspection** responses are complete and **Testing Calculations & Results** responses are positive (Y - yes)
☐	FAIL: Any **Construction Inspection** responses are incomplete *OR* there is one or more negative (N - no) responses in **Testing Calculations & Results** section. Provide explanation below. Use and attach additional pages if necessary.

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Packaged HVAC Systems Acceptance Document — MECH-3-A

NJ.4.1 — **Form __ of __**

PROJECT NAME		DATE
PROJECT ADDRESS		
TESTING AUTHORITY	TELEPHONE	
PACKAGED HVAC NAME / DESIGNATION		_____ Checked by/Date Enforcement Agency Use

Intent: Verify that under a specific load whether in occupied or unoccupied condition, the system meets a specific sequence of operation.

Construction Inspection

1 Instrumentation to perform test includes, but not limited to:
   a. None required

2 Installation
   ☐ Thermostat or zone temperature sensor is located within the zone that the HVAC system serves
   ☐ Thermostat or sensor is wired to the HVAC system correctly

3 Programming (check **all** of the following)
   ☐ Heating and cooling thermostats are capable of a 5°F deadband where cooling and heating are at a minimum (§122b3)
   ☐ Occupied, unoccupied, and holiday schedule have been programmed.
   ☐ Pre-occupancy purge (at least lesser of minimum outside air or 3 ACH for one hour prior to occupancy) programmed (§121.c.2)
   ☐ Set up and set back setpoints have been programmed as required

Certification Statement: I certify that all statements are true on this MECH-3-A form including the PASS/FAIL Evaluation. I affirm I am eligible to sign this form under the provisions described in the Statement of Acceptance on form MECH-1-A

Name: _____

Company: _____

Signature: _____ Date: _____

License: _____ Expires: _____

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Packaged HVAC Systems Acceptance Document	MECH-3-A
NJ.4.1	Form __ of __

PROJECT NAME	DATE

B. Equipment Testing Requirements — **Operating Modes**

Check and verify the following for each simulation mode required			A: Heating load during occupied condition	B: No-load during occupied condition	C: Heating load during unoccupied condition	D: No-load during unoccupied condition	E: Cooling load during occupied condition	F: Manual override	G: Cooling load during unoccupied condition
	1	Supply fan operates continually	☐	☐			☐	☐	
	2	Supply fan turns off				☐			
	3	Supply fan cycles on and off			☐				☐
	4	System reverts to "occupied" mode to satisfy any condition					☐		
	5	System turns off when manual override time period expires					☐		
	6	Gas-fired furnace, heat pump, or electric heater stages on	☐		☐				
	7	Neither heating or cooling is provided by the unit		☐		☐			
	8	No heating is provided by the unit		☐		☐		☐	☐
	9	No cooling is provided by the unit	☐	☐	☐	☐			
	10	Compressor stages on						☐	☐
	11	Outside air damper is open to minimum position	☐	☐			☐	☐	
	12	Outside air damper closes completely				☐			
	13	System returned to initial operating conditions after all tests have been completed	Y/N						

Note: Shaded areas do not apply for particular test procedure

C. Testing Results							
Indicate if Passed (P), Failed (F), or Not Applicable (X), fill in appropriate letter							

D. PASS / FAIL Evaluation (check one):	
☐	PASS: All **Construction Inspection** responses are complete and all applicable **Testing Results** responses are "Passed" (P)
☐	FAIL: Any **Construction Inspection** responses are incomplete *OR* there is one or more "Failed" (F) responses in **Testing Results** section. Provide explanation below. Use and attach additional pages if necessary.

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Economizer Acceptance Document — MECH-4-A

NJ.7.1 — **Form __ of __**

PROJECT NAME		DATE
PROJECT ADDRESS		
TESTING AUTHORITY	TELEPHONE	
AIR ECONOMIZER NAME / DESIGNATION		Checked by/Date Enforcement Agency Use

Intent: Verify that an HVAC system uses outside air to satisfy space cooling loads when outside air conditions are acceptable.

Construction Inspection

1 Instrumentation to perform test includes, but not limited to:
   a. Hand-held temperature probes
   b. Multi-meter capable of measuring ohms and milliamps

2 Test method (check one of the following):

☐ Economizer comes from HVAC system manufacturer installed by and has been factory calibrated and tested. **Attach documentation and complete certification statement. No equipment testing required.**

☐ Economizer field installed and field tested.

3 Installation (check **all** of the following first level boxes)

☐ Economizer high limit setpoint complies with Table 144-C per Standards Section 144(e)3

☐ System controls are wired correctly to ensure economizer is fully integrated (i.e. economizer will operate when mechanical cooling is enabled), if all boxes are checked for Standalone Control or EMS Control

Stand-alone Control Systems:

- ☐ HVAC unit has two-stage thermostat and the economizer is wired to be the first stage of control
- ☐ First stage of cooling (Y1) from thermostat is separately wired to Y1 at HVAC unit
- ☐ Second stage of cooling (Y2) from thermostat is separately wired to Y2 at HVAC unit
- ☐ Two stages of cooling are not jumpered or wired together

EMS Controlled Systems:

- ☐ Control sequence of operations will allow economizer to be integrated with cooling coil

☐ Economizer high limit control sensor(s) are properly installed

☐ System is provided with either barometric relief or powered relief (a relief fan or a return fan)

☐ Sensor(s) used for economizer high limit control has factory calibration certificate or is field calibrated. Sensors include: outside air sensor only if single-point changeover; both outside and return air sensors if differential changeover control. Field calibration is not necessary if economizer is factory installed.

Certification Statement: I certify that all statements are true on this MECH-4-A form including the PASS/FAIL Evaluation. I affirm I am eligible to sign this form under the provisions described in the Statement of Acceptance on form MECH-1-A

Name: _____

Company: _____

Signature: _____ Date: _____

License: _____ Expires: _____

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Economizer Acceptance Document	**MECH-4-A**
NJ.7.1	**Form __ of __**

PROJECT NAME	DATE

A. Equipment Testing	
Step 1: Simulate a cooling load and enable the economizer (check and verify the following)	
☐	Economizer damper modulates open to maximum position to provide 100% of design supply air quantity as outside air
☐	Return air damper modulates closed and is completely closed when economizer damper is 100% open
☐	Economizer damper is 100% open before mechanical cooling is enabled
☐	Relief is provided through barometric damper or powered relief (relief or return fan and exhaust damper)
☐	Mechanical cooling is only enabled if cooling space temperature setpoint is not met with economizer at 100% open
☐	There are no signs of building overpressurization
Step 2: Simulate a cooling load and disable the economizer (check and verify the following)	
☐	Economizer damper closes to minimum position
☐	Return air damper opens to normal operating position
☐	Relief fan (if applicable) shuts off or barometric relief dampers close. If system uses a return fan, the exhaust damper is shut.
☐	Mechanical cooling remains enabled until cooling space temperature setpoint is met
Step 3: System returned to initial operating conditions	Y / N

B. Testing Results	**PASS / FAIL**
Step 1: Simulate cooling load and enable the economizer (all check boxes are complete)	
Step 2: Simulate cooling load and disable the economizer (all check boxes are complete)	

C. PASS / FAIL Evaluation (check one):	
☐	PASS: All **Construction Inspection** responses are complete and all **Testing Results** responses are "Pass"
☐	FAIL: Any **Construction Inspection** responses are incomplete *OR* there is one or more "Fail" responses in **Testing Results** section. Provide explanation below. Use and attach additional pages if necessary.

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE MECH-5-A

NJ.5.1Air Distribution Acceptance Document Part 1 of 3

PROJECT NAME	DATE	TELEPHONE
PROJECT ADDRESS		
TESTING AUTHORITY		
AIR DISTRIBUTOR NAME / DESIGNATION	PERMIT NUMBER	Checked by/Date Enforcement Agency Use

Intent:	New single zone supply ductwork shall not exceed a 6% leakage rate per §144(k) or §149Di, existing single zone ductwork shall not exceed 15% leakage or other compliance path per §149Dii or §149E.

Construction Inspection

1 Scope of test – New Buildings – this test required on New Buildings only if all checkboxes 1(a) through 1(c) are checked

Existing Buildings – this test required if 1(a) through 1(d) are checked

Ductwork conforms to the following (note if any of these are not checked, then this test is not required):

☐	1a) Connected to a constant volume, single zone air conditioners, heat pumps, or furnaces
☐	1b) Serves less than 5000 square feet of floor area
☐	1c) Has more than 25% duct surface area located in one or more of the following spaces
	- Outdoors
	- A space directly under a roof where the U-factor of the roof is greater than U-factor of the ceiling
	- A space directly under a roof with fixed vents or openings to the outside or unconditioned spaces
	- An unconditioned crawlspace
☐	- Other unconditioned spaces 1d) A duct is extended or any of the following replaced: air handler, outdoor condensing unit of a split system, cooling or heating coil, or the furnace heat exchanger.

2 Instrumentation to perform test includes:

a. Fan flowmeter, manometer (pressure meter)

3 Material and Installation. Complying new duct systems shall have a checked box for all of the following categories a through f.

a. Choice of drawbands (check one of the following)

☐	Stainless steel worm-drive hose clamps
☐	UV-resistant nylon duct ties

☐	b. Flexible ducts are not constricted in any way
☐	c. Duct leakage tests performed before access to ductwork and connections are blocked
☐	d. Joints and seams are not sealed with cloth back rubber adhesive tape unless used in combination with Mastic and drawbands
☐	e. Duct R-values are verified R-8 per 124(a)
☐	f. Ductwork located outdoors has insulation that is protected from damage and suitable for outdoor service

Certification Statement

I certify that all statements are true on this MECH-5-A form including the PASS/FAIL Evaluation. I affirm I am eligible to sign this form under the provisions described in the Statement of Acceptance on form MECH-1-A

Name:		
Company:		
Signature:		Date:
License:		Expires:

INSTALLER CERTIFICATION — Part 2 of 3 — MECH-5-A

PROJECT NAME	DATE
SITE ADDRESS	PERMIT NUMBER

COPY TO: Building Department, Builder, Building Owner at Occupancy, HERS Provider

VERIFIED DUCT TIGHTNESS BY INSTALLER

The installing contractor must pressure test every new HVAC systems that meet the requirements of Section 144(k) and every retrofit to existing HVAC systems that meet the requirements of section 149 D or E (see Scope of Test under Construction Inspection)

RATED FAN FLOW (applies to all systems)		Measured Values	
1	Cooling capacity or for heating only units heating capacity		
	a) Cooling capacity (for all units but heating only units) in tons		
	b) Heating capacity (for heating only units) kBtu/h		
2	Fan flow calculation a) Cooling capacity in tons [_____(**Line # 1a**) x 400 cfm/ton] b) Heating only cap. kBtu/h [_____(**Line # 1b**) x (21.7 cfm/kBtu/h)]		
3	**Total calculated supply fan flow 2(a) or 2(b) cfm**		

NEW CONSTRUCTION OR ENTIRE NEW DUCT SYSTEM ALTERATION:			
	Duct Pressurization Test Results (CFM @ 25 Pa)		
4	Enter Tested Leakage Flow in CFM:		✓ ✓
5	Pass if Leakage Percentage ≤ 6%: [_____(**Line # 4**) /_____(**Line # 3**)] x 100	%	☐ Pass ☐ Fail
ALTERATIONS: Pre-existing Duct System with Duct Alteration and/or HVAC Equipment Change-Out			
6	Enter Tested Leakage Flow in CFM: **Pre-Test** of Existing Duct System Prior to Duct System Alteration and/or Equipment Change-Out.		
7	Enter Tested Leakage Flow in CFM: **Final Test** of New Duct System or Altered Duct System for Duct System Alteration and/or Equipment Change-Out.		
TEST OR VERIFICATION STANDARDS: For Altered Duct System and/or HVAC Equipment Change-Out Use one of the following Three Tests or Verification Standards for compliance:			
			✓ ✓
8	Pass if Leakage Percentage ≤ 15% [_____**(Line # 7)** / _____**(Line # 3)**] x 100	% 	☐ Pass ☐ Fail
9	Pass if Leakage Reduction Percentage ≥ 60% Leakage reduction = [1 - [_____**(Line#7)** / _____**(Line#6)**]} x 100	% 	☐ Pass ☐ Fail
10	Pass if all Accessible Leaks are sealed as confirmed by Visual Inspection and Verification by HERS rater (sampling rate 100%)		☐ Pass ☐ Fail
	Pass if One of Lines #8 through # 10 pass		☐ Pass ☐ Fail

INSTALLER COMPLIANCE STATEMENT

The building was: ✓ ☐ Tested at Final ☐ Tested at Rough-in

✓ ☐ I, the undersigned, verify that the above diagnostic test results and the work I performed associated with the test(s) is in conformance with the requirements for compliance credit. I, the undersigned, also certify that the newly installed or retrofit Air-Distribution System Ducts, Plenums and Fans comply with Mandatory requirements specified in Section 124 of the 2005 Building Energy Efficiency Standards.

Name:			
Company:			
Signature:		Date:	
License:		Expires:	

INSTALLER CERTIFICATION Part 3 of 3 MECH-5-A

HERS Rater: Telephone:	Sample Group Number:
Certifying Signature:	Sample building Number:
Firm:	HERS Provider:
Copies to: Builder, Building Owner at Occupancy, Building Department (wet signature), HERS Provider	

For new buildings the HERS rater must test and field verify the first individual single zone package space conditioning equipment unit of each building. After the first unit passes the builder shall identify a group of up to seven package units in the building from which one sample will be selected for testing. If this first sampled unit fails the HERS rater must pick another package unit from the group for testing. If the second unit in the group does not pass the HERS rater must test all package units in the group.

For existing buildings the HERS rater must pressure test one out of every seven units a contractor changes. Same rules apply for sampling above.

This page must be filled out by the HERS rater for all tested and sampled buildings. If the installer has not tested every system and provided a MECH-5-A to the HERS rater sampling must not occur.

The unit was: ✓ ☐ Tested ✓ ☐ Approved as part of sample testing but was not tested

As the HERS rater providing diagnostic testing and field verification, I certify that the building identified on this form complies with the diagnostic tested compliance requirements as checked ✓ on this form. The HERS rater must verify the distribution system on every new TESTED system to make sure that it is fully ducted and correct tape is used before a MECH-5-A may be released.

☐ The installer has provided a completed MECH-5-A for every system in the group
☐ New distribution systems are fully ducted (i.e., does not use building cavities as plenums or platform returns in lieu of ducts).
☐ In new duct systems, where cloth backed, rubber adhesive duct tape is installed, mastic and draw bands are used in combination with cloth backed, rubber adhesive duct tape to seal leaks at duct connections.

	RATED FAN FLOW (applies to all systems)	Measured Values	
1	Cooling capacity or for heating only units heating capacity		
	a) Cooling capacity (for all units but heating only units) [_____ tons x 400 cfm/ton]		
	b) Heating capacity (for heating only units) [_____ kBtuh x 21.7 cfm/kBtuh]		
2	**Total calculated supply fan flow 1(a) or 1(b) cfm**		
	NEW CONSTRUCTION OR ENTIRE NEW DUCT SYSTEM ALTERATION:		
3	Duct Pressurization Test Results (CFM @ 25 Pa) Enter Tested Leakage Flow in CFM:		✓ ✓
4	Pass if Leakage Percentage ☐ 6%: [_____(**Line # 3**) / _____(**Line # 2**)] x 100	%	☐ Pass ☐ Fail
	ALTERATIONS: Pre-existing Duct System with Duct Alteration and/or HVAC Equipment Change-Out		
5	Enter Tested Leakage Flow in CFM: **Final Test** of New Duct System or Altered Duct System for Duct System Alteration and/or Equipment Change-Out.		
	TEST OR VERIFICATION STANDARDS: For Altered Duct System and/or HVAC Equipment Change-Out, Use one of the following Three Tests or Verification Standards for compliance:		
6	Pass if Leakage Percentage ☐ 15% [_____**(Line # 5)** / _____**(Line # 2)**] x 100	%	☐ Pass ☐ Fail
7	For systems certified by the installer as reducing leakage, pass if Leakage Reduction ☐ 60%. $\text{LeakageReduction} = 1 - \frac{\text{(Line\#5 HERS Tested Leakage)}}{\text{(Line\#6 Installer's Certified Pre-Test Leakage)}}$] x 100	%	☐ Pass ☐ Fail
8	Pass if all Accessible Leaks are sealed as confirmed by Visual Inspection and Verification by HERS rater (sampling rate 100%)		☐ Pass ☐ Fail
	Pass if One of Lines # 6 through # 8 pass		☐ Pass ☐ Fail

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Demand Control Ventilation Acceptance Document — MECH-6-A

NJ.8.1 — Form __ of __

PROJECT NAME		DATE
PROJECT ADDRESS		
TESTING AUTHORITY	TELEPHONE	
DCV NAME / DESIGNATION		_____ Checked by/Date Enforcement Agency Use

Intent: Verify outside air ventilation flow rate can be modulated automatically based on maintaining interior carbon dioxide concentration setpoint.

Construction Inspection

1 Instrumentation to perform test may include, but not limited to:
   a. Calibrated hand-held CO2 analyzer
   b. Manufacturer's calibration kit
   c. Calibrated CO2/air mixtures

2 Installation
   ☐ The sensor is located in the room between 1 ft and 6 ft above the floor
   ☐ System controls are wired correctly to ensure proper control of outdoor air damper system

3 Documentation of all carbon dioxide control sensors includes (check one of the following):
   a. Calibration method
      ☐ Factory-calibration certificate
      ☐ Field calibrated
   b. Sensor accuracy
      ☐ Certified by manufacturer to be no more than +/- 75 ppm

Certification Statement: I certify that all statements are true on this MECH-6-A form including the PASS/FAIL Evaluation. I affirm I am eligible to sign this form under the provisions described in the Statement of Acceptance on form MECH-1-A

Name: _____

Company: _____

Signature: _____ Date: _____

License: _____ Expires: _____

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Demand Control Ventilation Acceptance Document	**MECH-6-A**
NJ.8.1	**Form __ of __**

PROJECT NAME	DATE

A. Equipment Testing	
a. Verify economizer controls disabled	
b. Outside air CO2 concentration (select one of the following)	
☐ Assumed to be 400 ppm	_____ ppm
☐ Measured dynamically using CO2 sensor	_____ ppm
c. Interior CO2 concentration setpoint (Outside CO2 concentration + 600 ppm)	_____ ppm
Step 1: Simulate a high CO2 load	
☐ Outdoor air damper modulates opens per Standards toward maximum position to satisfy outdoor air requirements specified in Section 121(c)4, Table 121-A.	
Step 2: Simulate a low CO2 load, or increase CO2 setpoint	
☐ Outdoor air damper closes to minimum position during occupancy	
Step 3: System returned to initial operating conditions	Y / N

B. Testing Results	**PASS / FAIL**
Step 1: Simulate a high CO2 load (check box complete)	
Step 2: Simulate a low CO2 load (check box complete)	

C. PASS / FAIL Evaluation (check one):	
☐	PASS: All **Construction Inspection** responses are complete and all **Testing Results** responses are "Pass"
☐	FAIL: Any **Construction Inspection** responses are incomplete *OR* there is one or more "Fail" responses in **Testing Results** section. Provide explanation below. Use and attach additional pages if necessary.

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Supply Fan VFD Acceptance Document — MECH-7-A

NJ.9.1 — **Form __ of __**

PROJECT NAME		DATE
PROJECT ADDRESS		
TESTING AUTHORITY	TELEPHONE	
VFD NAME / DESIGNATION		_____ Checked by/Date — Enforcement Agency Use

Intent: Verify that the supply fan in a variable air volume application modulates to meet air flow demand and operating parameters are within +/-10% of design value and/or setpoint.

Construction Inspection

1 Instrumentation to perform test includes, but not limited to:
   a. Differential pressure gauge

2 Test preparation
   ☐ Disable discharge air temperature reset sequences to prevent unwanted interaction while performing tests

3 Documentation of all discharge static pressure sensors including (check one of the following):
   a. Factory-calibrated (proof required)
      ☐ Factory-calibration certificate
   b. Field-calibrated
      ☐ Calibration complete, all pressure sensors within 10% of calibrated reference sensor

Certification Statement: I certify that all statements are true on this MECH-7-A form including the PASS/FAIL Evaluation. I affirm I am eligible to sign this form under the provisions described in the Statement of Acceptance on form MECH-1-A

Name: _____

Company: _____

Signature: _____ Date: _____

License: _____ Expires: _____

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Supply Fan VFD Acceptance Document — MECH-7-A

NJ.9.1 — **Form __ of __**

PROJECT NAME	DATE

A. Equipment Testing			Results
Step 1: Drive all VAV boxes to achieve design airflow			
2.	Witness proper response from supply fan (e.g. VFD near 100%; variable pitch blades loaded)		Y / N
3.	Controller supply air static pressure setpoint at full flow		
4.	Measured supply fan discharge static pressure	In. WC=	
5.	Time for system to stabilize to full flow	Minutes =	
Step 2: Drive all VAV boxes to minimum flow			
6.	Witness proper response from supply fan (e.g. VFD slows fan speed; variable pitch blades unloaded)		Y / N
7.	Controller supply air static pressure setpoint at minimum flow		
8.	Measured supply fan discharge static pressure	In. WC=	
9.	Time for system to stabilize to minimum flow	Minutes =	
Step 3: System returned to initial operating conditions			Y / N

B. Test Calculations and Results			
Compare design static pressure with controller setpoint and measured pressure at full flow			
1.	Ratio Measured static pressure / controller pressure setpoint at full flow **(A.4./A.3.)**	%=	
2.	90% < Measured static pressure / Controller pressure setpoint, at full flow **(B.2.)** < 110%		Y / N
3.	System stabilizes to full flow within 15 minutes (no hunting): **A.5. < 15 minutes**		Y / N
Compare controller setpoint to measured pressure at minimum flow and setpoint at full flow			
4.	Controller pressure setpoint at min flow ≤ controller pressure setpoint at full flow **(A.7. ≤ A.3.)**		Y / N
5.	Ratio Measured static pressure / Controller pressure setpoint at min flow **(A.8./A.7.)**	%=	
6.	90% < Measured static pressure / Controller pressure setpoint, at min flow **(B.5.)** < 110%		Y / N
7.	System stabilizes to minimum flow within 15 minutes (no hunting): **A.9. < 15 minutes**		Y / N

C. PASS / FAIL Evaluation (check one)	
☐	PASS: All **Construction Inspection** responses are complete and **Testing Results** responses are positive (Y - yes)
☐	FAIL: Any **Construction Inspection** responses are incomplete *OR* there is one or more negative (N - no) responses in **Testing Results** section. Provide explanation below. Use and attach additional pages if necessary.

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Hydronic System Control Acceptance Document — MECH-8-A

NJ.10.1 - NJ.10.5 — Form __ of __

PROJECT NAME		DATE
PROJECT ADDRESS		
TESTING AUTHORITY	TELEPHONE	
HYDRONIC SYSTEM NAME / DESIGNATION		_____ Checked by/Date Enforcement Agency Use

Intent: Satisfy HVAC water pumping requirements per Section 144(j).

Construction Inspection

1 Instrumentation to perform tests include, but not limited to:
   a. Differential pressure gauge
   b. Portable temperature probe

2 Variable Flow Controls (VFC) and Automatic Isolation Controls (AIC) Inspection

VFC AIC

☐ ☐ Valve and piping arrangements were installed per the design drawings to achieve the desired control

3 Supply Water Temperature Reset Controls Inspection

- ☐ Supply temperature sensors have been calibrated
  - ☐ Manufacturer's calibration certificates (attached)
  - ☐ Site calibration within 2° F of temperature measurement with reference meter
- ☐ Sensor locations are adequate to achieve accurate measurements
- ☐ Installed sensors comply with specifications

4 Water-loop Heat Pump Controls Inspection

- ☐ Valves were installed per the design drawings to achieve equipment isolation requirements
- ☐ All sensor locations comply with design drawings

5 Variable Frequency Drive Controls Inspection

- ☐ All valves, sensors, and equipment were installed per the design drawings
- ☐ Pressure sensors are calibrated
  - ☐ Manufacturer's calibration certificates (attached)
  - ☐ Site calibration within 10% of pressure measurement with reference meter

Certification Statement: I certify that all statements are true on this MECH-8-A form including the PASS/FAIL Evaluation. I affirm I am eligible to sign this form under the provisions described in the Statement of Acceptance on form MECH-1-A

Name: _____

Company: _____

Signature: _____ Date: _____

License: _____ Expires: _____

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Hydronic System Control Acceptance Document — MECH-8-A

NJ.10.1 - NJ.10.5 — Form __ of __

PROJECT NAME	DATE

			System ID				
A.	**System Type**		**1**	**2**	**3**	**4**	**5**
	1	Chilled water					
	2	Heating hot water					
	3	Water-loop heat pump loop					
	4	Other (fill in blank):					
	5	Other (fill in blank):					
B.	**Select Acceptance Test (check all tests completed)**		**1**	**2**	**3**	**4**	**5**
☐	Variable Flow Control - Alternate 1 (Flow measurement)						
☐	Variable Flow Control - Alternate 2 (No flow measurement)						
☐	Automatic Isolation Controls						
☐	Supply Water Temperature Reset Controls						
☐	Water-loop Heat Pump Controls - Alternate 1 (With Flow Meter)						
☐	Water-loop Heat Pump Controls - Alternate 2 (Without Flow Meter)						
☐	(Pump) Variable Frequency Drive Controls - Alternate 1(With Flow Meter)						
☐	(Pump) Variable Frequency Drive Controls - Alternate 2(Without Flow Meter)						

	C. Equipment Testing Requirements		System ID				
	Verify and document the following (check applicable tests)		**1**	**2**	**3**	**4**	**5**
	NJ 10.1 Variable Flow Control - Alternate 1 (Flow measurement)						
	Step 1: Open all control valves.						
a.	Measured system flow (gpm)	GPM =					
b.	Design system flow (gpm)	GPM =					
c.	System operation achieves design conditions		☐	☐	☐	☐	☐
	Step 2: Initiate closure of control valves						
a.	Measured system flow (gpm)	GPM =					
b.	Design system flow (gpm)	GPM =					
c.	Design pump flow control strategy achieves flow reduction requirements		☐	☐	☐	☐	☐
d.	Ensure all valves operate correctly against the system pressure		☐	☐	☐	☐	☐
	Step 3: System returned to initial operating conditions		Y / N	Y / N	Y / N	Y / N	Y / N
	NJ.10.1 Variable Flow Control- Alternate 2 (No flow measurement)						
	Step 1:Drive all valves shut and dead head pump against manual isolation valve						
a.	Measured pressure across the pump (ft. H20)	ΔP=					
	Step 2: Open manual isolation valve and measure pump DP with control valves closed						
a.	Measured pressure across the pump (ft. H20)	ΔP=					
b.	Both shutoff pressures are within +/- 5% of each other		☐	☐	☐	☐	☐
	Step 3: System returned to initial operating conditions		Y / N	Y / N	Y / N	Y / N	Y / N
	NJ.10.2 Automatic Isolation Controls						
	Step 1:Drive all valves shut and dead head pump against manual isolation valve						
a.	Measured pressure across the pump (ft. H20)	ΔP=					
	Step 2: Open manual isolation valve and start/stop each chiller or boiler one at a time						
a.	Verify automatic isolation valve opens fully when respective unit is ON		☐	☐	☐	☐	☐
b.	Verify automatic isolation valve closes fully when respective unit is OFF		☐	☐	☐	☐	☐
	Step 3: Stop all chillers and boilers on the hydronic loop						
a.	Measured pressure across the pump (ft. H20)	ΔP=					
b.	Both shutoff pressures (1a and 3a) are within +/- 5% of each other		☐	☐	☐	☐	☐
	Step 4: System returned to initial operating conditions		Y / N	Y / N	Y / N	Y / N	Y / N

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Hydronic System Control Acceptance Document — MECH-8-A

NJ.10.1 - NJ.10.5 — Form __ of __

PROJECT NAME			DATE				
NJ.10.3 Supply Water Temperature Reset Controls							
Step 1: Manually change design control variable to maximum setpoint							
a.	Reset temperature setpoint	°F =					
b.	Measured water temperature	°F =					
c.	Water temperature setpoint is reset to appropriate value		☐	☐	☐	☐	☐
d.	Actual water supply temperature meets setpoint		☐	☐	☐	☐	☐
Step 2: Manually change design control variable to minimum setpoint							
a.	Reset temperature setpoint	°F =					
b.	Measured water temperature	°F =					
c.	Water temperature setpoint is reset to appropriate value		☐	☐	☐	☐	☐
d.	Actual water supply temperature meets setpoint		☐	☐	☐	☐	☐
Step 3: System returned to initial operating conditions			Y / N	Y / N	Y / N	Y / N	Y / N
NJ 10.4 Water-loop Heat Pump Controls (for circulation pumps > 5 hp) - Alternate 1 (Flow measurement)							
Step 1: Open all control valves							
a.	Measured system flow (gpm)	GPM =					
b.	Design system flow (gpm)	GPM =					
c.	System operation achieves design conditions +/- 5% (Step 1.a./Step 1.b.)		☐	☐	☐	☐	☐
Step 2: Initiate shut-down sequence on each individual heat pumps							
a.	Isolation valves close automatically upon unit shut-down		☐	☐	☐	☐	☐
b.	Ensure all valves operate correctly at shut-off system pressure conditions		☐	☐	☐	☐	☐
c.	System flow reduced for each individual heat pump shut down		☐	☐	☐	☐	☐
Step 3: System returned to initial operating conditions			Y / N	Y / N	Y / N	Y / N	Y / N
NJ.10.4 Water-loop Heat Pump Controls (for circulation pumps > 5 hp) - Alternate 2 (No flow measurement)							
Step 1:Drive all valves shut and dead head pump against manual isolation valve							
a.	Measured pressure across the pump (ft. H20)	ΔP=					
Step 2: Open manual isolation valve and measure pump DP with automatic isolation valves closed							
a.	Measured pressure across the pump (ft. H20)	ΔP=					
b.	Both shutoff pressures are within +/- 5% of each other		☐	☐	☐	☐	☐
Step 3: System returned to initial operating conditions			Y / N	Y / N	Y / N	Y / N	Y / N
NJ.10.5 (Pump) Variable Frequency Drive Controls - Alternate 1 (With Flow Meters)							
Step 1: Open all control valves							
a.	Measured system flow (gpm)	GPM =					
b.	Design system flow (gpm)	GPM =					
c.	Design pump power (estimated by motor HP/ motor efficiency x 0.746 kW/HP)	kW =					
d.	System operation achieves design conditions +/- 5% (Step 1.a./Step 1.b.)		☐	☐	☐	☐	☐
e.	VFD operates near 100% speed at full flow		☐	☐	☐	☐	☐
Step 2: Modulate control valves closed							
a.	Ensure all valves operate correctly at system pressure conditions		☐	☐	☐	☐	☐
b.	Witness proper response from VFD (speed decreases as valves close)		☐	☐	☐	☐	☐
c.	Time for system to stabilize	Min =					
d.	System operation stabilizes within 5 min. after test procedures are initiated		☐	☐	☐	☐	☐
Step 3: Adjust system operation to achieve 50% flow							
a.	Measured system flow (gpm)	GPM =					
b.	Measured pump power at full flow	kW =					
c.	%Power = part load kW/full load design kW (Step 3.b. / Step 1.c.)	% =					
d.	VFD input power less than 30% of design		☐	☐	☐	☐	☐
Step 4: Adjust to achieve flow rate where VFD is below min speed setpoint							
a.	VFD minimum setpoint	Hz =					
b.	Ensure VFD maintains minimum speed setpoint		☐	☐	☐	☐	☐
Step 5: System returned to initial operating conditions			Y / N	Y / N	Y / N	Y / N	Y / N

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Hydronic System Control Acceptance Document — MECH-8-A

NJ.10.1 - NJ.10.5 — Form __ of __

PROJECT NAME	DATE

NJ.10.5 (Pump) Variable Frequency Drive Controls - Alternate 2 (Without Flow Meters)						
Step 1: Open all control valves						
a.	Visually inspect a few valves to verify that they open					
b.	Time for system to stabilize Min =					
c.	System operation stabilizes within 5 min. after test procedures are initiated	☐	☐	☐	☐	☐
d.	VFD operates near 100% speed at full flow	☐	☐	☐	☐	☐
e.	Measured pressure at loop pressure sensor control point *(psi or ft WC)*					
Step 2: Modulate control valves closed						
a.	Visually inspect a few valves to verify that they close	☐	☐	☐	☐	☐
b.	Witness proper response from VFD (speed decreases as valves close)	☐	☐	☐	☐	☐
c.	Time for system to stabilize Min =					
d.	System operation stabilizes within 5 min. after test procedures are initiated	☐	☐	☐	☐	☐
e.	Measured pressure at loop pressure sensor control point *(psi or ft WC)*					
f.	Measured pressure with valves closed ≤ pressure with valves open	☐	☐	☐	☐	☐
Step 3: System returned to initial operating conditions		Y / N	Y / N	Y / N	Y / N	Y / N

D. PASS / FAIL Evaluation (check one):

☐ PASS: All applicable **Construction Inspection** responses are complete and applicable **Equipment Testing Requirements** check boxes are compete.

☐ FAIL: Any applicable **Construction Inspection** responses are incomplete *OR* there is one or more unchecked box for an applicable test in the **Equipment Testing Requirements** section. Provide explanation below. Use and attach additional pages if necessary.

2005 CERTIFICATE OF ACCEPTANCE (Part 1 of 3) LTG-1-A

PROJECT NAME		DATE
PROJECT ADDRESS		
TESTING AUTHORITY	TELEPHONE	_____ Checked by/Date Enforcement Agency Use

GENERAL INFORMATION

DATE OF BLDG. PERMIT	PERMIT #	BLDG. CONDITIONED FLOOR AREA	CLIMATE ZONE

BUILDING TYPE	☐ NONRESIDENTIAL	☐ HIGH RISE RESIDENTIAL	☐ HOTEL/MOTEL GUEST ROOM
PHASE OF CONSTRUCTION	☐ NEW CONSTRUCTION	☐ ADDITION ☐ ALTERATION	☐ UNCONDITIONED

STATEMENT OF ACCEPTANCE

This Certificate of Acceptance summarizes the results of the acceptance tests related to building mechanical requirements per Title 24, Part 6. (Sections 10-103.b, 121.f, 122.h, 125.a, 125.b, 125.c, 125.c.5, 125.d)

Please check one:

[I hereby affirm that I am eligible under the provisions of Division 3 of the Business and Professions Code to sign this document as the person responsible for it's preparation; and that I am licensed in the State of California as a civil engineer or electrical engineer, or I am a licensed architect.

[I affirm that I am eligible under the exemption to Division 3 of the Business and Professions Code by Section 5537.2 or 6737.3 to sign this document as the person responsible for its preparation; and that I am a licensed contractor performing this work.

[I affirm that I am eligible under the exemption to Division 3 of the business and Professions Code to sign this document because it pertains to a structure or type of work described pursuant to Business and Professions Code sections 5537, 5538, and 6737.1.

(These sections of the Business and Professions Code are printed in full in the Nonresidential Manual.)

TESTING AUTHORITY - NAME	SIGNATURE	DATE	LIC.#

INSTRUCTIONS TO APPLICANT

For Detailed instructions on the use of this and all Energy efficiency Standards acceptance forms, please refer to the Nonresidential Manual published by the California Energy Commission.

Part 1 of 3 - Statement of Acceptance
Part 2 of 3 - Summary of Acceptance Tests
Part 3 of 3 - Summary of Acceptance Testing Results

2005 CERTIFICATE OF ACCEPTANCE (Part 2 of 3) LTG-1-A

PROJECT NAME	DATE

SUMMARY OF ACCEPTANCE TESTS

SYSTEM ACCEPTANCE DOCUMENT (Form __ of __)	TESTING AUTHORITY	DATE OF TEST	PASS / FAIL	NOTES Bldg. Dept. Use

NOTE: Use additional sheets as necessary

2005 CERTIFICATE OF ACCEPTANCE (Part 3 of 3) LTG-1-A

PROJECT NAME	DATE

SUMMARY OF ACCEPTANCE TESTING RESULTS

Certified	N / A	Testing Authority Certifies That:
Occupant & Motion Sensors		
☐	☐	The occupant sensors with ultrasonic radiation as a signal for sensing occupants shall meet the requirements of Standard Section 119.d.1.
☐	☐	The occupant sensors with microwave radiation as a signal for sensing occupants shall meet the requirements of Standard Section 119.d.2.
Automatic Daylighting Controls		
☐	☐	The continuous dimming control systems meet the requirements of Section 119(e).
☐	☐	The stepped dimming control systems meet the requirements of Section 119(e).
☐	☐	The stepped switching control systems meet the requirements of Section 119(e).
Automatic Time Switch Controls		
☐	☐	The automatic time switch control devices meet the requirements of 119(c).
Manual Daylighting Controls		
☐	☐	The manual daylighting controls meet the requirements of……

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Lighting Control Acceptance Document — LTG-2-A

Form __ of __

PROJECT NAME		DATE
PROJECT ADDRESS		Checked by/Date Enforcement Agency Use
TESTING AUTHORITY	TELEPHONE	
LIGHTING CONTROL SYSTEM NAME / DESIGNATION		

Intent: Lights are turned off when not needed per 119(d) & 131(d).

Construction Inspection

1 Instrumentation to perform test includes, but not limited to:
   a. Light meter
   b. Hand-held amperage and voltage meter
   c. Power meter

2 Occupancy Sensor Construction Inspection
   ☐ Occupancy sensor has been located to minimize false signals
   ☐ Occupancy sensors do not encounter any obstructions that could adversely effect desired performance
   ☐ Ultrasonic occupancy sensors do not emit audible sound (119a) 5 feet from source

3 Manual Daylighting Controls Construction Inspection
   ☐ If dimming ballasts are specified for light fixtures within the daylit area, make sure they meet all the Standards requirements, including "reduced flicker operation" for manual dimming control systems

4 Automatic Time Switch Controls Construction Inspection
   a. Automatic time switch control is programmed for (check all):
      ☐ Weekdays
      ☐ Weekend
      ☐ Holidays
   b. Document for the owner automatic time switch programming (check all):
      ☐ Weekdays settings
      ☐ Weekend settings
      ☐ Holidays settings
      ☐ Set-up settings
      ☐ Preference program setting
   ☐ Verify the correct time and date is properly set in the time switch
   ☐ Verify the battery is installed and energized
   ☐ Override time limit is no more than 2 hours

Certification Statement: I certify that all statements are true on this LTG-2-A form including the PASS/FAIL Evaluation.

I affirm I am eligible to sign this form under the provisions described in the Statement of Acceptance on form LTG-1-A

Name: _____

Company: _____

Signature: _____ Date: _____

License: _____ Expires: _____

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Lighting Control Acceptance Document — LTG-2-A

Form __ of __

PROJECT NAME	DATE

A. Select Acceptance Test (Indicate lighting control systems Names/Designations by the applicable tests below)

☐	**1**	Occupancy Sensor
☐	**2**	Manual Daylighting Controls
☐	**3**	Automatic Time Switch Controls

B. Equipment Testing Requirements		**Applicable Lighting Control Systems**		
Check and verify those items applicable to selected system:		**1**	**2**	**3**
Occupancy Sensor - Step 1: Simulate an unoccupied condition				
a.	Lights controlled by occupancy sensors turn off within a maximum of 30 minutes from start of an unoccupied condition per Standard Section 119(d)	Y / N		
b.	The occupant sensor does not trigger a false "on" from movement in an area adjacent to the controlled space or from HVAC operation	Y / N		
c.	Signal sensitivity is adequate to achieve desired control	Y / N		
Step 2: Simulate an occupied condition				
a.	Status indicator or annunciator operates correctly	Y / N		
b.	Lights controlled by occupancy sensors turn on when Immediately upon an occupied condition *OR* (this requirement is mutually exclusive with Step 2.c.)	Y / N		
c.	Sensor indicates space is "occupied" and lights turn on manually	Y / N		
Step 3: System returned to initial operating conditions		Y / N		
Manual Daylighting Controls - Step 1: Manual switching control				
a.	At least 50% of lighting power in daylit areas is separately controlled from other lights		Y / N	
b.	The amount of light delivered to the space is uniformly reduced		Y / N	
Step 2: System returned to initial operating conditions			Y / N	
Automatic Time Switch Controls - Step 1: Simulate occupied condition				
a.	All lights can be turned on and off by their respective area control switch			Y / N
b.	Verify the switch only operates lighting in the ceiling-height partitioned area in which the switch is located			Y / N
Step 2: Simulate unoccupied condition				
a.	All non-exempt lighting turn off per Section 131(d)1			Y / N
b.	Manual override switch allows only the lights in the selected ceiling height partitioned space where the override switch is located, to turn on or remain on until the next scheduled shut off occurs			Y / N
c.	All non-exempt lighting turns off			Y / N
Step 3: System returned to initial operating conditions				Y / N

Note: Shaded areas do not apply for particular test procedure

C. PASS / FAIL Evaluation (check one):

☐	PASS: All applicable **Construction Inspection** responses are complete and all applicable **Equipment Testing Requirements** responses are positive (Y - yes)
☐	FAIL: Any applicable **Construction Inspection** responses are incomplete *OR* there is one or more negative (N - no) responses in any applicable **Equipment Testing Requirements** section. Provide explanation below. Use and attach additional pages if necessary.

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Automatic Daylighting Controls Acceptance Document — LTG-3-A

Form __ of __

PROJECT NAME		DATE
PROJECT ADDRESS		
TESTING AUTHORITY	TELEPHONE	
AUTOMATIC DAYLIGHTING CONTROL NAME / DESIGNATION		_____ Checked by/Date Enforcement Agency Use

Intent: Verify operation of daylighting systems meet 119(e)2.

Construction Inspection

1 Instrumentation to perform test includes, but not limited to:
   a. Light meter
   b. Hand-held amperage and voltage meter
   c. Power meter

2 Documentation of all control devices (photocells) have been properly located including:
   a. Factory-calibrated (proof required)
      ☐ Factory-calibration certificate attached
   b. Field-calibrated
      ☐ Setpoint properly set
      ☐ Lighting threshold

3 Documentation has been provided by the installer for:
   ☐ Setpoints for each device
   ☐ Settings for each device
   ☐ Programming for each device

4 Luminaires controlled by automatic daylighting controls are only in daylit areas; and
   ☐ Separately circuited for daylit areas by windows and daylit areas under skylights

Certification Statement: I certify that all statements are true on this LTG-3-A form including the PASS/FAIL Evaluation.

I affirm I am eligible to sign this form under the provisions described in the Statement of Acceptance on form LTG-1-A

Name: _____

Company: _____

Signature: _____ Date: _____

License: _____ Expires: _____

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE

Automatic Daylighting Controls Acceptance Document — LTG-3-A

Form __ of __

PROJECT NAME	DATE

A.		**Control System** (check all applicable systems and list lighting control systems Names/Designations)
☐	**1**	Continuous Dimming Control Systems
☐	**2**	Stepped Dimming Control Systems
☐	**3**	Stepped Switching Control Systems

B.	**Equipment Testing Requirements**	**Applicable Control System**		
Check and verify those applicable to specific simulation mode:		**1**	**2**	**3**
Step 1: Simulate bright conditions				
a.	Measured lighting power at fully dimmed condition kW =			
b.	Rated lighting power at full light output kW =			
c.	Lighting power reduced by at least 50% in daylit area by windows and at least 65% in daylit areas under skylights.	Y / N		
d.	Only luminaries in daylit zone are affected by daylight control	Y / N	Y / N	Y / N
e.	Automatic daylight control system reduces the amount of light delivered to the space uniformly	Y / N		
f.	Dimming control system provides reduced flicker operation over the entire operating range per Standards Section 119(e)2.	Y / N		
g.	Lumen measurements in the space, location of measurements and specific device settings, program setting and other measurements are documented	Y / N	Y / N	Y / N
h.	Automatic daylight control system reduces the amount of light delivered to the space relatively uniformly as per Section 131(b)		Y / N	
I.	Lighting power reduced by at least 50% in daylit area by windows and at least 65% in daylit areas under skylights.		Y / N	Y / N
j.	Automatic daylight control system reduces the amount of light delivered to the space per manufacturer's specifications for power level versus light level		Y / N	Y / N
k.	Minimum time delay between step changes is 3 minutes to prevent short cycling		Y / N	
l.	Lighting power reduction is at least 50% under fully switched conditions per Standards Section 119(e)1			Y / N
m.	Single- or multiple-stepped switching controls provide a dead band of at least three minutes between switching threshold to prevent short cycling			Y / N
Step 2: Simulate dark conditions				
a.	Dimming control system provides reduced flicker operation over the entire operating range per Standards Section 119(e)2.	Y / N	Y / N	
b.	Lumen measurements in the space, location of measurements and specific device settings, program setting and other measurements are documented	Y / N	Y / N	Y / N
c.	Automatic daylight control system increases the amount of light delivered to the space uniformly	Y / N	Y / N	Y / N
d.	Minimum time delay between step changes is 3 minutes to prevent short cycling		Y / N	
e.	Single- or multiple-stepped switching controls provide a dead band of at least three minutes between switching threshold to prevent short cycling			Y / N
Step 3: System returned to initial operating conditions		Y / N	Y / N	Y / N

C.	**PASS / FAIL Evaluation (check one):**
☐	PASS: All applicable **Construction Inspection** responses are complete and all applicable **Equipment Testing Requirements** responses are positive (Y - yes)
☐	FAIL: Any applicable **Construction Inspection** responses are incomplete *OR* there is one or more negative (N - no) responses in any applicable **Equipment Testing Requirements** section. Attach additional pages with explanation.

HERS Field Verification and Diagnostic Testing for Duct Sealing

Note: the fallowing pages are excerpts from the *Nonresidential Alternative Calculation Method Approval Manual P400-03-004F.*

HERS Field Verification and Diagnostic Testing for Duct Sealing

The Building Energy Efficiency Standards for nonresidential, high-rise residential and hotel/motel buildings (Sections 144 (k) for newly constructed buildings, 149 (a) 1 and 149 (a) 2 for additions, and 149 (b) 1 D and 149 (b) 1 E for alterations to existing buildings) contain requirements for field verification and diagnostic testing by a certified HERS (Home Energy Rating System) rater for duct sealing. For buildings that have used a measure for compliance that requires HERS rater field verification and diagnostic testing, Section 10-103 (e) 2 requires that building departments not approve the building until the building department has received a Certificate of Field Verification and Diagnostic Testing (CF-4R) that has been signed and dated by the HERS rater. The Commission approves HERS providers, subject to the Commission's HERS regulations, which appear in the California Code of Regulations, Title 20, 1670-1675.

The purpose of this section is to put in one place the regulations directly related to HERS field verification and diagnostic testing so that building officials, builders, installing contractors, energy consultants, HERS providers and raters and other people who have a role in successful compliance for measures requiring HERS field verification and diagnostic testing can easily locate the requirements. This section includes:

- Chapter 7 of the Residential ACM Manual, which provides detailed information for what procedures must be followed to complete the field verification process for duct sealing,
- appendix NG, which provides the protocols that builders, installing contractors and raters must use to complete field verification for duct sealing,
- compliance forms necessary for documenting measures that require field verification and diagnostic testing, including the *HERS Verification Required* features on the *Mechanical Compliance Summary* (MECH-1A), and *Mechanical Distribution Summary* (MECH-5A).
- the HERS regulations, which explains the duties of HERS providers, the obligations of raters to provide true, accurate and complete reports of field verification findings (Section 1672 (d), and rules for avoiding conflicts-of-interest between raters and builders and between raters and installing contractors (Section 1673 (i).

Readers should recognize that the Nonresidential Compliance Manual provides further clarification of the HERS rater field verification and diagnostic testing process as it relates to specific measures (the reader could search for "HERS" or "field verification" to find pertinent sections). The Nonresidential Compliance Manual is on the Commission's website at: http://www.energy.ca.gov/2005publications/CEC-400-2005-006/CEC-400-2005-006-CMF.PDF.

Duct Efficiency Improvements Including HERS Required Field Verification and Diagnostic Testing for Duct Sealing

Note: the fallowing pages are excerpts from the *Nonresidential Alternative Calculation Method Approval Manual P400-03-004F*.

7. Duct Efficiency Improvements Including HERS Required Field Verification and Diagnostic Testing for Duct Sealing

7.1 Duct Efficiency Improvements

The Commission has approved algorithms and procedures for determining HVAC air distribution system (duct) efficiency for non-residential single-zone packaged equipment units serving 5000 ft^2 or less via ductwork that is installed in buffer spaces or unconditioned areas.. Details of the energy efficiency calculations are presented in Appendix NG.

Section 144(k) of the Standards sets a prescriptive requirement for HERS rater diagnostically tested and field verified duct sealing for duct systems that meet the following criteria (note this is a subset of the duct systems for which the ACM calculations shall be applied):

1. Connected to constant volume, single zone, air conditioners, heat pumps or furnaces, and
2. Serving less than 5,000 square feet of floor area; and
3. Having more than 25% duct surface area located in one or more of the following spaces:
   A. Outdoors, or
   B. In a space directly under a roof where the U-factor of the roof is greater than the U-factor of the ceiling, or
   C. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces, or
   D. In an unconditioned crawlspace; or
   E. In other unconditioned spaces.

This requirement applies to new buildings and to additions. Section 149(b)1.D sets a requirement for HERS rater diagnostically tested and field verified duct sealing for alterations of existing buildings where a new duct system is being installed or an existing duct system is being replaced for duct systems meeting the same criteria. Section 149(b)1.E sets a requirement for HERS rater diagnostically tested and field verified duct sealing for existing duct systems in duct systems meeting the same criteria when the space conditioning system is being installed or replaced, including replacement or installation of an air handler, cooling or heating coil, or furnace heat exchanger. Section 124 sets a mandatory minimum duct insulation requirement of R-8 for duct systems meeting the same criteria.

There are two calculation procedures to determine HVAC system air distribution (duct) efficiency using either: 1) default input assumptions, or 2) values based on HERS rater diagnostic testing and field verification. Duct efficiencies for heating and cooling shall be calculated separately. The ACM shall require the user to choose values for the following parameters to calculate duct efficiencies: duct insulation level and duct leakage level.

For duct systems in new buildings and additions meeting the section 144(k) criteria, the ACM shall assume R-8 duct insulation and duct leakage of 8% of fan flow for the standard design. For the proposed design the same R-8 duct insulation value shall be used since that is a mandatory requirement. When the documentation author specifies duct sealing, which requires HERS rater field verification and diagnostic testing, the proposed design for duct leakage shall be the same as the standard design. If the documentation does not specify duct sealing, the proposed design shall be the default value for duct leakage of 36% of fan flow.

For new or replacement duct systems in existing buildings meeting the Section 144(k) criteria, the ACM shall assume R-8 duct insulation for the new or replaced ducts, and if the new or replaced ducts make up only a portion of the duct system, the ACM shall assume R-4.2 duct insulation for the existing ducts. The proposed design shall use the same R-8 duct insulation for the new or replaced ducts and the actual installed duct insulation for the existing ducts. The ACM shall assume duct leakage of 17% of fan flow for the standard design for new or replacement duct systems, including existing portions of the duct system. When the documentation author specifies duct sealing meeting the requirements of Section 149(b)1.D, including HERS rater field verification and diagnostic testing, the proposed design for duct leakage shall be the same as the standard design. If the documentation does not specify duct sealing, the proposed design shall be the default value of duct leakage of 36% of fan flow.

For existing duct systems in existing buildings meeting the Section 144(k) criteria, the ACM shall assume R-4.2 duct insulation and duct leakage of 17% of fan flow. The proposed design shall assume either R-4.2 duct insulation or the actual installed duct insulation. The ACM shall assume duct leakage of 17% of fan flow for the standard design for new or replacement duct systems, including existing portions of the duct system. When the documentation author specifies duct sealing meeting the requirements of Section 149(b)1.E, including HERS rater field verification and diagnostic testing, the proposed design for duct leakage shall be the same as the standard design. If the documentation does not specify duct sealing, the proposed design shall be the default value for duct leakage of 36% of fan flow.

For duct systems for single-zone individual packaged equipment serving 5000 ft^2 or less via ductwork that is installed in spaces that are not directly conditioned, which do not meet the Section 144(k) criteria, the ACM shall assume R4.2 duct insulation for the standard design. The proposed design shall assume either R4.2 or the actual installed duct insulation. The ACM shall assume the default value for duct leakage of 36% of fan flow. When the documentation author specifies duct sealing, including HERS rater field verification and diagnostic testing, the proposed design shall assume duct leakage of 8% of fan flow for duct systems in new buildings and additions meeting the duct leakage requirements of Section 144(k), and duct leakage of 17% for duct systems in existing buildings meeting the duct leakage requirements of Sections 149(b)1.D or 149(b)1.E.

The ACM shall automatically determine whether duct systems are for single-zone individual packaged equipment serving 5000 ft^2 or less via ductwork that is installed in spaces that are not directly conditioned, and whether such duct systems meet the criteria of Section 144(k). This determination shall be made based on inputs required for analyzing other HVAC features or inputs created especially to make this determination. The ACM shall automatically use the following values from the description of the proposed design when calculating the distribution system (duct) efficiency:

- Number of stories
- Building Conditioned Floor Area
- Building Volume
- Outdoor summer and winter design temperatures for each climate zone

When more than one HVAC system serves the building, the HVAC distribution efficiency is determined for each system and is applied to the energy consumption of each system.

Duct sealing shall be listed as *HERS Verification Required* features on the *Performance Certificate of Compliance* (PERF-1) and the *Mechanical Compliance Summary* (MECH-1), and *Mechanical Distribution Summary* (MECH-5). Field verification and diagnostic testing constitutes "eligibility and installation criteria" for duct sealing. Field verification and diagnostic testing of duct sealing shall be described in the *Compliance Supplement*.

7.2 California Home Energy Rating Systems

Compliance credit for duct sealing for HVAC systems covered by sections 144(k), 149(b)1.D and 149(b)1.E of the Standards requires field verification and diagnostic testing of as-constructed duct systems by a certified HERS rater, using the testing procedures in Appendix NG. The Commission approves HERS providers, subject to the Commission's HERS Program regulations, which appear in the California Code of Regulations, Title 20, Chapter 4, Article 8, Sections 1670-1676). Approved HERS providers are authorized to certify HERS raters and maintain quality control over field verification and diagnostic testing. When User's Manual and Help System indicates field verification and diagnostic testing of specific energy efficiency improvements as a condition for those improvements to qualify for Title 24 compliance credit, an approved HERS provider and certified HERS rater shall be used to conduct the field verification and diagnostic testing. HERS providers and raters shall be considered special inspectors by building departments, and shall demonstrate competence, to the satisfaction of the building official, for the field verifications and diagnostic testing. The HERS provider and rater shall be independent entities from the builder or subcontractor installer of the energy efficiency improvements being tested and verified, and shall have no financial interest in the installation of the improvements. Third-party quality control programs approved by the Commission may serve the function of HERS raters for field verification and diagnostic testing purposes as specified in Section 7.6.

7.3 Summary of Documentation and Communication

The documentation and communication process for duct sealing field verification and diagnostic testing is summarized below. The subsequent sections of this chapter contain additional information.

- The documentation author and the principal mechanical designer shall complete the compliance documents, including the MECH-1 for the building.
- The documentation author or the principal mechanical designer shall provide a signed Certificate of Compliance (MECH-1) to the builder, which indicates that duct sealing with HERS rater diagnostic testing and field verification is required for compliance. The builder or principal mechanical designer shall make arrangements for the services of a certified HERS rater prior to installation of the duct system, so that once the installation is complete the HERS rater has ample time to complete the field verification and diagnostic testing without delaying final approval of occupancy by the building department.
- The builder's subcontractor installs the duct systems which require field verification and diagnostic testing, as specified by Section 7.1. The builder or builder's installer shall complete diagnostic testing and the procedures specified in Section 7.5. When the installation is complete, the builder or the builder's subcontractor shall complete the installer's portion of the MECH-5, Mechanical Distribution Summary, and keep it at the building site for review by the building department. The builder also shall provide a copy of the completed installer's portion of the MECH-5 to the HERS rater.
- The HERS rater shall complete the field verification and diagnostic testing as specified in Section 7.1, completes the HERS rater's portion of the MECH-5, and provides a signed MECH-5 to the HERS provider, builder and building department. The building department shall not approve a building with individual single zone package space conditioning equipment unit for occupancy until the building department has received a MECH-5 that has been signed by the certified HERS rater.

7.4 Installation Certification

When compliance includes duct sealing, builder employees or subcontractors shall complete diagnostic testing, and certify on the installer's portion of the (MECH-5) the diagnostic test results and that the work meets the requirements for compliance credit.
Installer certifications are required for each and every building, and for every single zone package space conditioning equipment unit in the building that requires duct sealing with HERS rater field verification and diagnostic testing, if more than one such space conditioning equipment unit is installed in the building.

7.5 Field Verification and Diagnostic Testing Procedures

At the builder's option, HERS field verification and diagnostic testing shall be completed either for each single zone package space conditioning equipment unit in the building or for a sample of all of the units that are installed in the building. Field verification and diagnostic testing for compliance credit for duct sealing shall use the diagnostic duct leakage from fan pressurization of ducts in ACM Appendix NG.

The builder shall provide the HERS provider a copy of the MECH-5 containing the installer certifications required in Section 7.5. Prior to completing field verification and diagnostic testing, the HERS rater shall first verify that the installation certifications have been completed. If the builder chooses the sampling option, the procedures described in this section shall be followed. Sampling procedures described in this section shall be included in the *Compliance Supplement*.

7.5.1 Initial Field Verification and Testing

The HERS rater shall diagnostically test and field verify the first individual single zone package space conditioning equipment unit of each building. This initial testing allows the builder to identify and correct any potential duct installation and sealing flaws or practices before other units are installed. If field verification and diagnostic testing determine that the requirements for compliance are met, the HERS rater shall provide a signed and dated MECH-5 to the builder, the HERS provider, and the building department.

7.5.2 Sample Field Verification and Testing

After the initial testing is completed, the builder shall identify a group of up to seven individual single zone package space conditioning equipment units in the building from which a sample will be selected for testing, and notify the HERS provider.

The builder may remove units from the group by notifying the HERS provider. Removed units which are installed shall either be field verified and diagnostically tested individually or shall be included in a subsequent group for sampling.

The HERS rater shall select a minimum of one unit out of the group for diagnostic testing and field verification. When several units are ready for testing at the same time, the HERS rater shall randomly select the unit to be tested. The HERS rater shall diagnostically test and field verify the unit selected by the HERS rater.

If field verification and diagnostic testing determines that the requirements for compliance are met, the HERS rater shall provide a signed and dated MECH-5 to the builder, the HERS provider, and the building department. The MECH-5 shall report the successful diagnostic testing results and conclusions regarding compliance for the tested unit. The HERS rater shall also provide a signed and dated MECH-5 to the builder, the HERS provider, and the building department for up to six additional units in the group. The MECH-5 shall not be provided for units that have not yet been installed and sealed.

Whenever the builder changes subcontractors who are responsible for installation of the space conditioning equipment units, the builder shall notify the HERS rater of any subcontractors who have changed, and terminate sampling for the identified group. All units requiring HERS rater field verification and diagnostic testing for compliance that were installed by previous subcontractors or were subject to field verification and diagnostic testing under the supervision of a previous HERS provider, for which the builder does not have a completed MECH-1, shall either be individually tested or included in a separate group for sampling. Individual single zone package space conditioning equipment units that are subject to the requirements of Section 144(k) with installations completed by new subcontractors shall either be individually tested or shall be included in a new sampling group following a new *Initial Field Verification and Testing*.

The HERS rater shall not notify the builder when sample testing will occur prior to the completion of the work that is to be tested. After the HERS rater notifies the builder when testing will occur, the builder shall not do additional work on the features being tested.

7.5.3 Re-sampling, Full Testing and Corrective Action

When a failure is encountered during sample testing, the HERS rater shall conduct re-sampling to assess whether that failure is unique or the rest of the units are likely to have similar failings. The HERS rater shall select for re-sampling one of the up to six untested units in the group.

If testing in the units in the re-sample confirms that the requirements for compliance credit are met, then the unit with the failure shall not be considered an indication of failure in the other units in the group. The HERS rater shall provide a signed and dated MECH-5 to the builder, the HERS provider, and the building department for up to six additional units in the group, including the unit in the re-sample. The builder shall take corrective action for the unit with the failure, and then the HERS rater shall retest that unit to verify compliance and issue a signed and dated to the builder.

If field verification and testing in the re-sample results in a second failure, the builder shall take corrective action in all space conditioning units in the group that have not been tested. In cases where corrective action would require destruction of building components, the builder may choose to reanalyze compliance and choose different measures that will achieve compliance. In this case a new Certificate of Compliance (MEC-1) shall be completed and submitted to the HERS provider, HERS rater and building department. The HERS rater shall conduct field verification and diagnostic testing for each of these space conditioning units to verify that problems have been corrected and that the requirements for compliance have been met, and shall report to the HERS provider, the builder, and the building department.

The HERS provider shall file a report with the building department explaining all action taken (including field verification, testing, and corrective action,) to bring into compliance units for which full testing has been required. If corrective action requires work not specifically exempted by Section 112 of the CMC or Section 106 of the CBC, the builder shall obtain a permit from the building department prior to commencement of any of the work.

If additional units in the group are completed during the time required to correct, field verify and test the previously installed units in the group, the rater shall individually field verify and diagnostically test those additional units to confirm that the requirements for compliance credit are met.

Corrections shall not be made to a sampled or re-sampled unit to avoid a failure. If corrections are made to a sampled or re-sampled unit to avoid a failure, corrections, field verification and testing shall be performed on 100% of the individual single zone package space conditioning equipment units in the group.

7.6 Third Party Quality Control Programs

The Commission may approve third-party quality control programs that serve the function of HERS raters for diagnostic testing and field verification purposes. The third-party quality control program shall provide training to installers regarding compliance requirements for measures for which diagnostic testing and field verification is required. The third-party quality control program shall collect data from participating installers for each installation completed for

compliance credit, complete data checking analysis to evaluate the validity and accuracy of the data to independently determine whether compliance has been achieved, provide direction to the installer to retest and correct problems when data checking determines that compliance has not been achieved, require resubmission of data when retesting and correction is directed, and maintain a database of all data submitted by installers in a format that is acceptable to the Commission and available to the Commission upon request. The data that is collected by the third-party quality control program shall be more detailed than the data required for showing compliance with the Standards, shall provide an independent check on the validity and accuracy of the installer's claim that compliance has been achieved, and shall not be alterable by the installer to indicate that compliance has been achieved when in fact compliance has not been achieved.

The third-party quality control program shall also obtain the services of a HERS rater to conduct independent field verifications, completing all of the responsibilities of a HERS rater as specified in this chapter with the exception that sampling shall be completed for a group of up to thirty space conditioning units with a minimum sample of one out of every 30 sequentially completed units from the group. The HERS rater shall be an independent entity from the third-party quality control program. Re-sampling, full testing and corrective action shall be completed as specified in Section 7.5.3 with the exception that re-sampling shall be completed for a minimum of one out of every 30 units from the group.

The third-party quality control program shall meet all of the requirements of a HERS rater specified in the Commission's HERS Program regulations (California Code of Regulations, Title 20, Division 2, Chapter 4, Article 8, Sections 1670 -1675), including the requirement to be an independent entity from the builder and the HERS rater that provides independent field verifications, subcontractor installer as specified by Section 1673(i). A third-party quality control program may have business relationships with installers participating in the program to advocate or promote the program and an installer's participation in the program, and to advocate or promote products that the third-party quality control program sells to installers as part of the program.

Prior to approval by the Commission, the third-party quality control program shall provide a detailed explanation to the Commission of 1) the data that is to be collected from the installers, 2) the data checking process that will be used to evaluate the validity and accuracy of the data, 3) the justification for why this data checking process will provide strong assurance that the installation actually complies, and 4) the format for the database that will be maintained and provided to the Commission upon request. The third-party quality control program may apply for a confidential designation of this information as specified in the Commission's Administrative Regulations (California Code of Regulations, Title 20, Division 2, Chapter 7, Article 2, Section 2505). The third-party quality control program shall also provide a detailed explanation of the training that will be provided to installers, and the procedures that it will follow to complete independent field verifications.

The third-party quality control program shall be considered for approval as part of the rating system of a HERS provider, which is certified as specified in the Commission's HERS Program regulations, Section 1674. A third-party quality control program can be added to the rating system through the re-certification of a certified HERS provider as specified by Section 1674(d).

7.7 Sampling for Additions or Alterations

When compliance for an addition or alteration requires diagnostic testing and field verification, the building permit applicant may choose for the testing and field verification to be completed for the permitted space alone or as part of a sample of space conditioning units for which the same installing company has completed work that requires testing and field verification for compliance. The building permit applicant shall complete the applicable portions of a MECH-1. The HERS provider shall define the group for sampling purposes as all units where the building permit applicant has chosen to have testing and field verification completed as part of a sample for the same installing company. The group shall be no larger than seven. The installing company may request a smaller group for sampling. Whenever the HERS rater for an installing company is changed, a new group shall be established. Initial field verification and testing shall be completed for the first unit in each group. Re-sampling, full testing and corrective action shall be completed if necessary as specified by Section 7.5.3.

Field verification and diagnostic testing may be completed by an approved third-party quality control program as specified in Section 7.6. The group for sampling purposes shall be no larger than 30 when a third-party quality control program is used. The third-party quality control program may define the group instead of the provider. When a third-party quality control program is used, the MECH-5 shall document that data checking has indicated that the unit complies. The building official may approve compliance based on the MECH-5 where data checking has indicated that the unit complies, on the condition that if sampling indicates that re-sampling, full testing, and corrective action is necessary, such work shall be completed.

7.8 Summary of Responsibilities

This section summarizes responsibilities described previously in this chapter and organizes them by the responsible party.

7.8.1 Builder

The builder shall make arrangements for the services of a certified HERS rater prior to installation of the duct systems, so that once the installation is complete the HERS rater has ample time to complete the field verification and diagnostic testing without delaying final approval of occupancy by the building department.

Builder employees or subcontractors responsible for completing diagnostic testing, as specified in Section 7.5 shall certify the diagnostic testing results and that the work meets the requirements for compliance credit on the installer's portion of the MECH-5.

If the builder chooses to have HERS rater field verification and diagnostic testing completed through sampling, the builder shall identify for the HERS provider the group of space conditioning units to be included in the sample. The builder shall provide the HERS provider a copy of the MECH-5 with the installer's portion signed by the builder employees or sub-contractors, certifying that diagnostic testing and installation meet the requirements for compliance credit.

The builder shall provide a MECH-5 signed and dated by the HERS rater to the building official in conjunction with requests for final inspection for each individual single zone package space conditioning equipment unit.

7.8.2 HERS Provider and Rater

The HERS provider shall maintain a list of the space conditioning units in the group from which sampling is drawn, the units selected for sampling, the units sampled and the results of the sampling, the units selected for re-sampling, the units that have been tested and verified as a result of re-sampling, the corrective action taken, and copies of all MECH-5 forms for a period of five years.

The HERS rater providing the diagnostic testing and verification shall sign and date a MECH-5 certifying that he/she has verified that the requirements for compliance credit have been met. A MECH-5 shall be provided for the tested space conditioning unit and each of up to six other units from the group for which compliance is verified based on the results of the sample. The HERS rater shall provide copies of the signed MECH-5 to the builder, the HERS provider, and the building department.

The HERS rater shall identify on the MECH-5 if the space conditioning unit has been tested or if it was an untested unit approved as part of sample testing. The HERS rater shall not sign a MECH-5 for a building with a space conditioning unit that does not have the installer's portion of the MECH-5 signed by the installer as required in Section 7.5.

If field verification and testing on a sampled space conditioning unit identifies a failure to meet the requirements for compliance credit, the HERS rater shall report to the HERS provider, the builder, and the building department that re-sampling will be required.

If re-sampling identifies another failure, the HERS rater shall report to the HERS provider, the builder, and the building department that corrective action and diagnostic testing and field verification will be required for all the untested space conditioning units in the group. This report shall identify each space conditioning unit that shall be fully tested and corrected.

The HERS provider shall also report to the builder once diagnostic testing and field verification has shown that the failures have been corrected for all of the space conditioning units.

When individual space conditioning unit testing and verification confirms that the requirements for compliance have been met, the HERS rater shall provide a signed and dated MECH-5 for each space conditioning unit in the group.

The HERS provider shall file a report with the building department explaining all action taken (including field verification, testing, and corrective actions) to bring into compliance space conditioning units for which full testing has been required.

7.8.3 Third-Party Quality Control Program

An approved third-party quality control program shall:

- Provide training to installers regarding compliance requirements for measures for which diagnostic testing and field verification is required,
- Collect data from participating installers for each installation completed for compliance credit,
- Complete data checking analysis to evaluate the validity and accuracy of the data to independently determine whether compliance has been achieved,

- Provide direction to the installer to retest and correct problems when data checking determines that compliance has not been achieved,
- Require resubmission of data when retesting and correction is directed, and
- Maintain a database of all data submitted in a format that is acceptable to the Commission and available to the Commission upon request.

The third-party quality control program shall obtain the services of an independent HERS rater to conduct independent field verifications, completing all of the responsibilities of a HERS rater as specified in this Chapter with the exception that sampling shall be completed for a group of up to 30 space conditioning units, and sampling and re-sampling shall be completed for a minimum of one out of every 30 sequentially completed units from the group.

7.8.4 Building Department

When the Certificate of Compliance (MECH-1) indicates duct sealing requiring HERS diagnostic testing and field verification for compliance, the building department shall verify that the Documentation Author has notified the HERS provider before accepting the MECH-1.

The building department at its discretion may require independent testing and field verification to be scheduled so that it can be completed in conjunction with the building department's required inspections, and/or observe the diagnostic testing and field verification performed by builder employees or subcontractors and the certified HERS rater in conjunction with the building department's required inspections to corroborate the results documented in installer certifications, and HERS rater field verifications on the MECH-5.

For space conditioning units that have used a compliance alternative that requires field verification and diagnostic testing, the building department shall not approve a building for occupancy until the building department has received a MECH-5 that has been signed and dated by the HERS rater.

Standard Procedure for Determining the Energy Efficiencies of Single-Zone Nonresidential Air Distribution Systems in Buffer Spaces or Outdoors

Note: the fallowing pages are excerpts from the *Nonresidential Alternative Calculation Method Approval Manual P400-03-004F*.

NONRESIDENTIAL ACM MANUAL APPENDIX NG

Appendix NG - Standard Procedure for Determining the Energy Efficiencies of Single-Zone Nonresidential Air Distribution Systems in Buffer Spaces or Outdoors

NG.1 Purpose and Scope

ACM NG contains procedures for measuring the air leakage in single zone, nonresidential air distribution systems and for calculating the annual and hourly duct system efficiency for energy calculations. The methods described here apply to single zone, constant volume heating and air conditioning systems serving zones with 5000 ft^2 of floor area or less, with duct systems located in unconditioned or semi-conditioned buffer spaces or outdoors. These calculations apply to new buildings or new air conditioning systems applied to existing buildings.

NG.2 Definitions

aerosol sealant closure system: A method of sealing leaks by blowing aerosolized sealant particles into the duct system which must include minute-by-minute documentation of the sealing process.

buffer space: an unconditioned or indirectly conditioned space located between a ceiling and the roof.

cool roof: a roofing material with high thermal emittance and high solar reflectance, or lower thermal emittance and exceptionally high solar reflectance as specified in Standards § 118 (i) that reduces heat gain through the roof.

delivery effectiveness: The ratio of the thermal energy delivered to the conditioned space and the thermal energy entering the distribution system at the equipment heat exchanger.

distribution system efficiency: The ratio of the thermal energy consumed by the equipment with the distribution system to the energy consumed if the distribution system had no losses or impact on the equipment or building loads.

equipment efficiency: The ratio between the thermal energy entering the distribution system at the equipment heat exchanger and the energy being consumed by the equipment.

equipment factor : F_{equip} is the ratio of the equipment efficiency including the effects of the distribution system to the equipment efficiency of the equipment in isolation.

fan flowmeter device: A device used to measure air flow rates under a range of test pressure differences.

floor area: The floor area of enclosed conditioned space on all floors of a building, as measured at the floor level of the exterior surfaces enclosing the conditioned space.

***Flow capture hood*:** A device used to capture and measure the airflow at a register.

load factor : F_{load} is the ratio of the building energy load without including distribution effects to the load including distribution system effects.

pressure pan : a device used to seal individual forced air system registers and to measure the static pressure from the register.

recovery factor : F_{recov} is the fraction of energy lost from the distribution system that enters the conditioned space.

thermal regain: The fraction of delivery system losses that are returned to the building.

NG.3 Nomenclature

a_r = duct leakage factor (1-return leakage) for return ducts

a_s = duct leakage factor (1-supply leakage) for supply ducts

$A_{duct,buffer}$ = total supply plus return duct area in buffer space, ft^2

$A_{duct,outdoor}$ = total supply plus return duct area located outdoors, ft^2

$A_{duct,n}$ = total supply plus return duct area in space n, ft^2

A_{floor} = conditioned floor area of building , ft^2

$A_{r,buffer}$ = return duct surface area in buffer space, ft^2

$A_{r,total}$ = total return duct surface area, ft^2

$A_{s,buffer}$ = supply duct surface area in buffer space, ft^2

$A_{s,total}$ = total supply duct surface area, ft^2

A_{walls} = area of buffer space exterior walls, ft^2

A_{roof} = area of buffer space roof, ft^2

B_r = conduction fraction for return

B_s = conduction fraction for supply

C_p = specific heat of air = 0.24 Btu/(lb·°F)

C_{DT}, C_0, C_R, C_L regression coefficients for hourly model

DE = delivery effectiveness

$DE_{seasonal}$ = seasonal delivery effectiveness

E_{equip} = rate of energy exchanged between equipment and delivery system, Btu/hour

E_{hr} = hourly HVAC system energy input (kW for electricity, therms for gas)

$F_{cycloss}$ = cyclic loss factor

F_{equip} = load factor for equipment

F_{leak} = fraction of system fan flow that leaks out of supply or return ducts

F_{load} = load factor for delivery system

F_{recov} = thermal loss recovery factor

F_{regain} = thermal regain factor

h_o = outside roof surface convection coefficient, = 3.4 Btu/hr ft^2°F

I_{hor} = global solar radiation on horizontal surface, Btu/hr ft^2

K_r = return duct surface area coefficient

K_s = supply duct surface area coefficient

N_{story} = number of stories of the building

P_{sp} = pressure difference between supply plenum and conditioned space [Pa]

P_{test} = test pressure for duct leakage [Pa]

Q_{buffer} = buffer space infiltration rate, cfm

Q_e = Flow through air handler at 400 cfm/rated ton with rated tons defined by unit scheduled capacity at the conditions the unit's ARI rating standard from Section 112 of the Standard. Airflow through heating only furnaces shall be based on a 21.7 cfm/kBtuh rated output capacity.

$Q_{total,25}$ = total duct leakage at 25 Pascal, cfm

R_r = thermal resistance of return duct, h ft^2 °F/Btu

R_s = thermal resistance of supply duct, h ft^2 °F/Btu

$T_{amb,cool}$ = cooling season ambient temperature, °F

$T_{amb,heat}$ = heating season ambient temperature, °F

$T_{amb,r}$ = ambient temperature for return, °F

$T_{amb,s}$ = ambient temperature for supply, °F

T_{in} = temperature of indoor air, °F

T_{solair} = sol-air temperature, °F

T_{sp} = supply plenum air temperature, °F

UA_c = UA value for the interface between the conditioned space and the buffer space, Btu/°F

UA_{walls} = UA value for the buffer space exterior walls, Btu/°F

UA_{roof} = UA value for the buffer space exterior roof, Btu/°F

UA_c = UA value for the interface between the conditioned space and the buffer space, Btu/°F

ZLC_c = zone loss coefficient for the interface between the conditioned space and the buffer space, Btu/°F

ZLC_{total} = sum of all the zone loss coefficients for the buffer space , Btu/°F

α = solar absorptivity of roof, = 0.70 for standard roof; 0.45 for cool roof, 0.0 for ducts located outdoors

ΔT_e = temperature rise across heat exchanger, °F

ΔT_r = temperature difference between indoors and the ambient for the return, °F

ΔT_s = temperature difference between indoors and the ambient for the supply, °F

ΔT_{sky} = reduction of sol-air temperature due to sky radiation, = 6.5°F for standard roof and cool roof, 0.0°F for ducts located outdoors, °F.

$\Delta T_{sol,hr}$ = hourly difference between sol-air and indoor temperatures, °F

$\Delta T_{sol,\,season}$ = energy weighted seasonal average difference between sol-air and indoor temperatures, °F

$\eta_{adj,hr}$ = hourly distribution efficiency adjustment factor

$\eta_{dist,seasonal}$ = seasonal distribution system efficiency

$\eta_{dist,hr}$ = hourly distribution system efficiency

ρ = density of air = 0.075, lb/ft^3

NG.4 Air Distribution Diagnostic Measurement and Default Assumptions

NG.4.1 Instrumentation Specifications

The instrumentation for the air distribution diagnostic measurements shall conform to the following specifications:

NG.4.1.1 Pressure Measurements

All pressure measurements shall be measured with measurement systems (i.e. sensor plus data acquisition system) having an accuracy of ± 0.2 Pa. All pressure measurements within the duct system shall be made with static pressure probes.

NG.4.1.2 Duct Leakage Measurements

The measurement of air flows during duct leakage testing shall have an accuracy of ±3% of measured flow using digital gauges.

All instrumentation used for duct leakage diagnostic measurements shall be calibrated according to the manufacturer's calibration procedure to conform to the above accuracy requirement. All testers performing diagnostic tests shall obtain evidence from the manufacturer that the equipment meets the accuracy specifications. The evidence shall include equipment model, serial number, the name and signature of the person of the test laboratory verifying the accuracy, and the instrument accuracy. All diagnostic testing equipment is subject to re-calibration when the period of the manufacturer's guaranteed accuracy expires.

NG.4.2 Apparatus

NG.4.2.1 Duct Pressurization

The apparatus for fan pressurization duct leakage measurements shall consist of a duct pressurization and flow measurement device meeting the specifications in Section NG.4.1.2.

NG.4.3 Procedure

The following sections identify input values for building and HVAC system (including ducts) using either default or diagnostic information.

NG.4.3.1 Building Information and Defaults

The calculation procedure for determining air distribution efficiencies requires the following building information:

1. climate zone for the building,

2. conditioned floor area,

3. number of stories,

4. areas and U-values of surfaces enclosing space between the roof and a ceiling, and

5. surface area of ductwork if ducts are located outdoors or in multiple spaces.

Using default values rather than diagnostic procedures produce relatively low air distribution-system efficiencies. Default values shall be obtained from following sections:

1. the location of the duct system in Section NG.4.3.4,
2. the surface area and insulation level of the ducts in Sections NG.4.3.3, NG.4.3.4 and NG.4.3.6,
3. the system fan flow in Section NG.4.3.7, and
4. the leakage of the duct system in Section NG.4.3.8.

NG.4.3.2 Diagnostic Input

Diagnostic inputs are used for the calculation of improved duct efficiency. The diagnostics include observation of various duct characteristics and measurement of duct leakage and system fan flows as described in Sections NG.4.3.5 through NG.4.3.8. These observations and measurements replace those assumed as default values.
The diagnostic procedures include:

- Measurement of total duct system leakage as described in Section NG.4.3.8.
- Measurement of duct surface area if ducts are located outdoors or in multiple spaces as described in Section 4.3.3.
- Observation of the insulation level for the supply (R_s) and return (R_r) ducts outside the conditioned space as described in Section NG.4.3.6.
- Observation of the presence of a cool roof.
- Observation of the presence of an outdoor air economizer.

NG.4.3.3 Duct Surface Area

The supply-side and return-side duct surface areas shall be calculated separately. If the supply or return duct is located in more than onespace, the area of that duct in each space shall be calculated separately. The duct surface area shall be determined using one of the following methods.

NG.4.3.3.1 Default Duct Surface Area

The default duct surface area for supply and return shall be calculated as follows:
For supplies:

Equation NG-1

$$A_{s,total} = K_s A_{floor}$$

Where K_s (supply duct surface area coefficient) shall be 0.25 for systems serving the top story only, 0.125 for systems serving the top story plus one other, and 0.08 for systems servings three or more stories.
For returns:

Equation NG-2 $$A_{r,total} = K_r \quad A_{floor}$$

Where K_r (return duct surface area coefficient) shall be 0.15 for systems serving the top story only, 0.125 for systems serving the top story plus one other, and 0.08 for systems servings three or more stories.

If ducts are located outdoors, the outdoor duct surface area shall be calculated from the duct layout on the plans using measured duct lengths and nominal inside diameters (for round ducts) or inside perimeters (for rectangular ducts) of each outdoor duct run in the building that is within the scope of the calculation procedure. When using the default duct area, outdoor supply duct surface area shall be less than or equal to the default supply duct surface area; outdoor return duct surface area shall be less than or equal to the default return duct surface area.

The surface area of ducts located in the buffer space between ceilings and roofs shall be calculated from:

Equation NG-3 $$A_{s,buffer} = A_{s,total} - A_{s,outdoors}$$

Equation NG-4 $$A_{r,buffer} = A_{r,total} - A_{r,outdoors}$$

NG4.3.3.2 Measured Duct Surface Area

Measured duct surface areas shall be used when the outdoor duct surface area measured from the plans is greater than default duct surface area for either supply ducts or return ducts. If a duct system passes through multiple spaces that have different ambient temperature conditions as specified in Section 4.3.5, the duct surface area shall be measured for each space individually. The duct surface area shall be calculated from measured duct lengths and nominal inside diameters (for round ducts) or inside perimeters (for rectangular ducts) of each duct run located in buffer spaces or outdoors.

NG.4.3.4 Duct Location

Duct systems covered by this procedure are those specified in the Standards § 144(k)3.

NG.4.3.5 Climate and Duct Ambient Conditions

Duct ambient temperatures for both heating and cooling shall be obtained from Tables NG-1a to NG-1e. The duct ambient temperatures for the cool roofs from Table NG-1c shall be used for ducts located in unconditioned spaces other than attics and outside. Indoor dry-bulb (T_{in}) temperature for cooling is 78°F. The indoor dry-bulb temperature for heating is 70°F.

Table NG-1a Assumptions for Duct Ceiling/Roof Space Ambient Temperature, Ceiling Insulation, No roof insulation, Non-vented Attic

Climate zone	Duct Ambient Temperature for Heating, T amb, heat	Duct Ambient Temperature for Cooling, T amb,, cool Standard roof without economizer	Duct Ambient Temperature for Cooling, T amb,, cool Cool roof without economizer	Duct Ambient Temperature for Cooling, T,amb, cool Standard roof with economizer	Duct Ambient Temperature for Cooling, T amb,, cool Cool roof with economizer
1	47.3	78.0	72.4	81.4	75.3
2	41.8	93.2	84.8	97.1	88.2
3	47.8	83.5	77.1	86.6	79.8
4	43.9	89.1	82.0	92.0	84.5
5	46.2	83.8	77.5	86.0	79.3
6	50.8	85.4	79.4	87.3	81.1
7	49.3	86.8	80.7	88.7	82.3
8	47.3	91.3	84.2	93.1	85.9
9	48.7	92.5	85.4	94.4	87.2
10	45.7	95.9	87.9	98.2	90.0
11	43.9	95.5	88.1	98.4	90.5
12	44.2	94.3	86.7	97.3	89.3
13	43.3	100.9	92.5	103.6	94.9
14	37.2	99.0	90.6	102.7	93.8
15	47.2	102.9	95.8	104.3	97.1
16	37.9	92.0	83.8	96.3	87.5

Table NG-1b Default Assumptions for Duct Ceiling/Roof Space Ambient Temperature, Ceiling Insulation, No roof insulation, Vented Attic

Climate zone	Duct Ambient Temperature for Heating, $T_{amb, heat}$	Duct Ambient Temperature for Cooling, $T_{amb,, cool}$ Standard roof without economizer	Duct Ambient Temperature for Cooling, $T_{amb,, cool}$ Cool roof without economizer	Duct Ambient Temperature for Cooling, $T_{,amb, cool}$ Standard roof with economizer	Duct Ambient Temperature for Cooling, $T_{amb,, cool}$ Cool roof with economizer
1	48.6	73.7	69.8	76.7	72.5
2	43.4	87.9	82.2	91.7	85.7
3	48.9	79.2	74.8	82.1	77.4
4	45.1	84.4	79.5	87.1	81.9
5	47.7	79.7	75.4	81.9	77.3
6	51.8	81.0	76.8	81.0	78.5
7	50.6	82.4	78.1	84.1	79.7
8	48.7	86.4	81.5	88.2	83.2
9	49.3	88.4	83.4	90.2	85.1
10	47.1	90.9	85.4	93.2	87.6
11	44.8	90.9	85.8	93.7	88.3
12	45.2	89.6	84.4	92.5	87.0
13	44.5	95.1	89.3	97.7	91.7
14	38.6	93.7	87.8	97.2	91.0
15	48.4	98.6	93.7	100.1	95.1
16	38.7	86.9	81.1	91.1	84.9

Table NG-1c Default Assumptions for Duct Ceiling/Roof Space Ambient Temperature, Ceiling Insulation, Roof insulation, Non-vented Attic

Climate zone	Duct Ambient Temperature for Heating, $T_{amb, heat}$	Duct Ambient Temperature for Cooling, $T_{amb,, cool}$ Standard roof without economizer	Duct Ambient Temperature for Cooling, $T_{amb,, cool}$ Cool roof without economizer	Duct Ambient Temperature for Cooling, $T_{,amb, cool}$ Standard roof with economizer	Duct Ambient Temperature for Cooling, $T_{amb,, cool}$ Cool roof with economizer
1	56.4	77.6	74.8	79.9	76.9
2	54.8	86.9	82.8	89.7	85.4
3	56.4	81.1	77.9	83.3	79.9
4	54.6	84.9	81.3	87.0	83.3
5	56.6	81.3	78.2	82.9	79.6
6	57.1	83.9	80.1	85.5	81.6
7	55.7	84.9	81.1	86.5	82.5
8	54.5	88.0	83.6	89.5	85.0
9	59.9	83.6	81.6	84.2	82.1
10	55.9	89.4	85.6	91.2	87.2
11	53.1	89.7	86.1	91.8	87.9
12	53.7	88.7	84.8	90.9	86.8
13	53.6	93.1	89.0	95.2	90.9
14	48.7	91.9	87.6	94.7	90.1
15	56.1	95.9	92.3	97.0	93.4
16	48.5	86.6	82.4	89.6	85.1

Table NG-1d Default Assumptions for Duct Ceiling/Roof Space Ambient Temperature, Roof Insulation, No Ceiling Insulation, Non-vented Attic

Climate zone	Duct Ambient Temperature for Heating, $T_{amb, heat}$	Duct Ambient Temperature for Cooling, $T_{amb,, cool}$ Standard roof without economizer	Duct Ambient Temperature for Cooling, $T_{amb,, cool}$ Cool roof without economizer	Duct Ambient Temperature for Cooling, $T_{,amb, cool}$ Standard roof with economizer	Duct Ambient Temperature for Cooling, $T_{amb,, cool}$ Cool roof with economizer
1	59.8	78.5	77.3	79.3	78.0
2	59.0	82.5	80.8	83.5	81.6
3	60.1	80.0	78.6	80.7	79.3
4	58.9	81.6	80.1	82.3	80.7
5	60.0	80.0	78.6	80.6	79.1
6	60.4	81.2	79.5	81.8	80.0
7	59.7	81.7	79.9	82.2	80.5
8	58.8	83.1	81.1	83.7	81.7
9	59.9	83.6	81.6	84.2	82.1
10	58.5	83.4	81.8	84.0	82.3
11	58.5	83.7	82.1	84.3	82.7
12	58.3	83.2	81.6	83.8	82.1
13	58.3	85.1	83.3	85.7	83.9
14	54.5	84.5	82.8	85.4	83.5
15	58.6	86.1	84.6	86.5	84.9
16	55.6	82.4	80.7	83.4	81.5

Table NG-1e Default Assumptions for Duct Ambient Temperature, Ducts Located Outdoors

Climate zone	Duct Ambient Temperature for Heating, $T_{amb, heat}$	Duct Ambient Temperature for Cooling, $T_{amb,, cool}$ Without economizer	Duct Ambient Temperature for Cooling, $T_{amb,, cool}$ With economizer
1	47.7	62.7	65.4
2	42.5	76.0	79.7
3	47.6	68.5	71.3
4	43.5	73.3	75.8
5	47.1	69.5	71.7
6	50.7	70.0	71.8
7	50.2	71.6	73.2
8	48.3	74.6	76.4
9	47.0	78.1	80.0
10	46.7	79.9	82.1
11	42.8	81.3	83.8
12	43.4	79.4	82.0
13	43.0	83.2	85.4
14	36.4	81.8	85.1
15	48.1	90.7	92.2
16	35.7	73.5	78.1

NG.4.3.6 Duct Wall Thermal Resistance

NG.4.3.6.1 Default Duct Insulation R value

Default duct wall thermal resistance for new buildings is R-8.0, the mandatory requirement for ducts installed in newly constructed buildings, additions and new or replacement ducts installed in existing buildings. Default duct wall thermal resistance for existing ducts in existing buildings is R-4.2. An air film resistance of 0.7 [h ft^2 ^oF/BTU] shall be added to the duct insulation R value to account for external and internal film resistance.

NG.4.3.6.2 Diagnostic Duct Wall Thermal Resistance

Duct wall thermal resistance shall be determined from the manufacturer's specification observed during diagnostic inspection. If ducts with multiple R values are installed, the lowest duct R value shall be used. If a duct with a higher R value than 8.0 is installed, the R-value shall be clearly stated on the building plans and a visual inspection of the ducts must be performed to verify the insulation values.

NG.4.3.7 Total Fan Flow

The total fan flow for an air conditioner or a heat pump for **all climate zones** shall be equal to 400 cfm/rated ton with rated tons defined by unit scheduled capacity at the conditions the unit's ARI rating standard from Section 112 of the Standard. Airflow through heating only furnaces shall be based on 21.7 cfm/kBtuh rated output capacity.

NG.4.3.8 Duct Leakage

NG.4.3.8.1 Duct Leakage Factor for Delivery Effectiveness Calculations

Default duct leakage factors for the Proposed Design shall be obtained from Table NG-2, using the "not Tested" values.
Duct leakage factors for the Standard Design shall be obtained from Table NG-2, using the appropriate "Tested" value.
Duct leakage factors shown in Table NG-2 shall be used in calculations of delivery effectiveness.

Table NG-2 Duct Leakage Factors

	as = ar =
Untested duct systems	0.82
Sealed and tested duct systems in existing buildings, System tested after HVAC equipment and/or duct installation	0.915
Sealed and tested new duct systems. System tested after HVAC system installation	0.96

NG.4.3.8.2 Diagnostic Duct Leakage
Diagnostic duct leakage measurement is used by installers and raters to verify that total leakage meets the criteria for any sealed duct system specified in the compliance documents. Table NG-3 shows the leakage criteria and test procedures that may be used to demonstrate compliance. In addition to the minimum tests shown, existing duct systems may be tested to show they comply with the criteria for new duct systems.

Table NG-3 Duct Leakage Tests

Case	User and Application	Leakage criteria, % of total fan flow	Procedure
Sealed and tested new duct systems	Installer Testing HERS Rater Testing	6%	NG 4.3.8.2.1
Sealed and tested altered existing duct systems	Installer Testing HERS Rater Testing	15% Total Duct Leakage	NG 4.3.8.2.1
	Installer Testing and Inspection HERS Rater Testing and Verification	60% Reduction in Leakage and Visual Inspection	NG 4.3.8.2.2 RC4.3.6 and RC4.3.7
	Installer Testing and Inspection HERS Rater Testing and Verification	Fails Leakage Test but All Accessible Ducts are Sealed And Visual Inspection	NG 4.3.8.2.3 RC4.3.6 and RC4.3.7

NG.4.3.8.2.1 Total Duct Leakage Test from Fan Pressurization of Ducts
The objective of this procedure is for an installer to determine or a rater to verify the total leakage of a new or altered duct system. The total duct leakage shall be determined by pressurizing both the supply and return ducts to 25 Pascals with all ceiling diffusers/grilles and HVAC equipment installed. When existing ducts are to be altered, this test shall be performed prior to and after duct sealing. The following procedure shall be used for the fan pressurization tests:

1. Verify that the air handler, supply and return plenums and all the connectors, transition pieces, duct boots and registers are installed. The entire system shall be included in the test.

2. For newly installed or altered ducts, verify that cloth backed rubber adhesive duct tape has not been used.

3 Seal all the supply and return registers, except for one return register or the system fan access. Verify that all outside air dampers and /or economizers are sealed prior to pressurizing the system.

4. Attach the fan flowmeter device to the duct system at the unsealed register or access door.

5. Install a static pressure probe at a supply.

6. Adjust the fan flowmeter to produce a 25 Pascal (0.1 in water) pressure difference between the supply duct and the outside or the building space with the entry door open to the outside.

7. Record the flow through the flowmeter ($Q_{total,25}$) - this is the total duct leakage flow at 25 Pascal's.

8. Divide the leakage flow by the total fan flow and convert to a percentage. If the leakage flow percentage is less than 6% for new duct systems or less than 15% for altered duct systems, the system passes.

Duct systems that have passed this total leakage test will be sampled by a HERS rater to show compliance.

NG 4.3.8.2.2 Leakage Improvement from Fan Pressurization of Ducts

For altered existing duct systems which have a higher leakage percentage than the Total Duct leakage criteria in Section NG 4.3.8.2.1, the objective of this test is to show that the original leakage is reduced through duct sealing as specified in Table NG-3. The following procedure shall be used:.

1. Use the procedure in NG 4.3.8.2.1 to measure the leakage before commencing duct sealing.

2. After sealing is complete use the same procedure to measure the leakage after duct sealing.

3. Subtract the sealed leakage from the original leakage and divide the remainder by the original leakage. If the leakage reduction is 60% or greater of the original leakage, the system passes.

4. Complete the Visual Inspection specified in NG 4.3.8.2.4.

Duct systems that have passed this leakage reduction test and the visual inspection test will be sampled by a HERS rater to show compliance.

NG 4.3.8.2.3 Sealing of All Accessible Leaks

For altered existing duct systems that do not pass the Total Leakage test (NG 4.3.8.2.1), the objective of this test is to show that all accessible leaks are sealed and that excessively damaged ducts have been replaced. The following procedure shall be used:

1. Complete each of the leakage tests

2. Complete the Visual Inspection as specified in NG 4.3.8.2.4.

All duct systems that could not pass either the total leakage test or the leakage improvement test will be tested by a HERS rater to show compliance. This is a sampling rate of 100%.

NG 4.3.8.2.4 Visual Inspection of Accessible Duct Sealing

For altered existing duct systems that fail to be sealed to 15% of total fan flow, the objective of this inspection is to confirm that all accessible leaks have been sealed and that excessively damaged ducts have been replaced. The following procedure shall be used:

1. Visually inspect to verify that the following locations have been sealed:

- Connections to plenums and other connections to the forced air unit
- Refrigerant line and other penetrations into the forced air unit
- Air handler door panel (do not use permanent sealing material, metal tape is acceptable)
- Register boots sealed to surrounding material
- Connections between lengths of duct, as well as connections to takeoffs, wyes, tees, and splitter boxes.

2. Visually inspect to verify that portions of the duct system that are excessively damaged have been replaced. Ducts that are considered to be excessively damaged are:

- Flex ducts with the vapor barrier split or cracked with a total linear split or crack length greater than 12 inches
- Crushed ducts where cross-sectional area is reduced by 30% or more
- Metal ducts with rust or corrosion resulting in leaks greater than 2 inches in any dimension
- Ducts that have been subject to animal infestation resulting in leaks greater than 2 inches in any dimension

NG 4.3.8.4 Labeling requirements for tested systems

A sticker shall be affixed to the exterior surface of the air handler access door with the following text in 14 point font:

"The leakage of the air distribution ducts was found to be CFM @ 25 Pascals or ___% of total fan flow.

This system (check one):

☐ *Has a leakage rate that is **equal to or lower** than the prescriptive requirement of 6% leakage for new duct systems or 15% leakage for alterations to existing systems. It meets the prescriptive requirements of California Title 24 Energy Efficiency Standards.*

☐ *Has a leakage rate **higher than** 6% leakage for new duct systems or 15% leakage for altered existing systems. It does NOT meet the meet or exceed the prescriptive requirements of the Title 24 standards. However, all accessible ducts were sealed.*

Signed: _____

Print name: _____

Print Company Name: _____

*Print Contractor License No:*_____

*Print Contractor Phone No:*_____

Do not remove sticker"

NG.4.4 Delivery Effectiveness (DE) Calculations

Seasonal delivery effectiveness shall be calculated using the seasonal design temperatures from Table NG-1.

NG.4.4.1 Calculation of Duct Zone Temperatures

The temperatures of the duct zones outside the conditioned space are determined in Section NG.4.3.5 for seasonal conditions for both heating and cooling.
For heating:

Equation NG-5 $$Tamb,s = Tamb,r = Tamb,heat$$

For cooling:

Equation NG-6 $$Tamb,s = Tamb,r = Tamb,cool$$

Where:
Tamb,heat and Tamb,cool are determined from values in Table NG.4.1.
If the ducts are not all in the same location, the duct ambient temperature for use in the delivery effectiveness and distribution system efficiency calculations shall be determined using an area weighted average of the duct ambient temperatures for heating and cooling:

Equation NG-7 $$T_{amb,heat} = \frac{A_{duct,buffer} \times T_{amb\ heat,buffer} + A_{duct,outdoors} \times T_{amb\ heat,\ outdoors}}{A_{duct,buffer} + A_{duct,outdoors}}$$

Equation NG-8 $$T_{amb,cool} = \frac{A_{duct,buffer} \times T_{amb\ cool,buffer} + A_{duct,outdoors} \times T_{amb\ cool,\ outdoors}}{A_{duct,buffer} + A_{duct,outdoors}}$$

where the buffer space ambient temperature shall correspond to the location yielding the lowest seasonal delivery effectiveness.
Alternatively, the duct ambient temperature for use in the delivery effectiveness and distribution system efficiency calculations can be determined using an area weighted average of the duct zone temperatures for heating and cooling in all spaces:

Equation NG-9 $$T_{amb,heat} = \frac{A_{duct,1} \times T_{amb\ heat,1} + A_{duct,,2} \times T_{amb\ heat,\ 2} + \ldots + A_{n} \times T_{amb\ heat,\ n}}{A_{duct,1} + A_{duct,2} + \ldots + A_{duct,n}}$$

Equation NG-10 $$T_{amb,cool} = \frac{A_{duct,1} \times T_{amb\,cool,1} + A_{duct,,2} \times T_{amb\,cool,2} + \ldots + A_{n} \times T_{amb\,cool,n}}{A_{duct,1} + A_{duct,2} + \ldots + A_{duct,n}}$$

NG.4.4.2 Seasonal Delivery Effectiveness (DE)

The supply and return conduction fractions, B_s and B_r, shall be calculated as follows:

Equation NG-11 $$B_s = \exp\left(\frac{-A_{s,out}}{1.08\,Q_e\,R_s}\right)$$

Equation NG-12 $$B_r = \exp\left(\frac{-A_{r,out}}{1.08\,Q_e\,R_r}\right)$$

The temperature difference across the heat exchanger in the following equation is used:
for heating:

Equation NG-13 $$\Delta T_e = 55$$

for cooling:

Equation NG-14 $$\Delta T_e = -20$$

The temperature difference between the building conditioned space and the ambient temperature surrounding the supply, $\Delta T_{s,}$ and return, ΔT_r , shall be calculated using the indoor and the duct ambient temperatures.

Equation NG-15 $$\Delta T_s = T_{in} - T_{amb,s}$$

Equation NG-16 $$\Delta T_r = T_{in} - T_{amb,r}$$

The seasonal delivery effectiveness for heating or cooling systems shall be calculated using:

Equation NG-17 $$DE_{seasonal} = a_s B_s - a_s B_s (1 - B_r a_r)\frac{\Delta T_r}{\Delta T_e} - a_s(1 - B_s)\frac{\Delta T_s}{\Delta T_e}$$

NG.4.5 Seasonal Distribution System Efficiency

Seasonal distribution system efficiency shall be calculated using delivery effectiveness, equipment, load, and recovery factors calculated for seasonal conditions.

NG.4.5.1 Equipment Efficiency Factor (F_{equip})

F_{equip} is 1.

NG.4.5.2 Thermal Regain (F_{regain})

The reduction in building load due to regain of duct losses shall be calculated using the thermal regain factor.

Equation NG-18

$$F_{regain} = \frac{ZLC_c}{ZLC_{total}}$$

where:

Equation NG-19

$$ZLC_c = UA_c + 60Q_e(1-a_r)\rho Cp$$

Equation NG-20

$$ZLC_{total} = \sum_{buffer spaces surfaces} UA + Q_{buffer}\rho Cp + 60Q_e(1-a_r)\rho Cp$$

Equation NG-21

$$UA_{buffer\ spaces\ surfaces} = UA_c + UA_{walls} + UA_{roof}$$

Equation NG-22

$$Q_{buffer} = 0.038(60)A_{walls}\rho c_p \text{ for non-vented buffer spaces}$$

Equation NG-23

$$Q_{buffer} = 0.25(60)A_{roof}\rho c_p \text{ for -vented buffer spaces}$$

Thermal regain for ducts located outdoors shall be equal to 0.0. If the ducts are not all in the same location, the regain shall be determined using an area weighted average of the regain for heating and cooling:

Equation NG-24

$$F_{regain} = \frac{A_{duct,1} \times F_{regain,1} + A_{duct,2} \times F_{regain,2} + \ldots + A_{duct,n} \times F_{regain,n}}{A_{duct,1} + A_{duct,2} + \ldots + A_{duct,n}}$$

NG.4.5.3 Recovery Factor (F_{recov})

The recovery factor, F_{recov}, is calculated based on the thermal regain factor, F_{regain}, and the duct losses without return leakage.

Equation NG-25

$$F_{recov} = 1 + F_{regain}\left(\frac{1 - a_s B_s + a_s B_s(1-B_r)\frac{\Delta T_r}{\Delta T_e} + a_s(1-B_s)\frac{\Delta T_s}{\Delta T_e}}{DE_{seasonal}}\right)$$

NG.4.5.4 Seasonal Distribution System Efficiency

The seasonal distribution system efficiency shall be calculated using the seasonal delivery effectiveness from section NG.4.4.2, the equipment efficiency factor from section NG.4.5.1, and the recovery factor from section NG.4.5.3. Note that $DE_{seasonal}$, F_{equip}, F_{recov} must be calculated separately for cooling and heating conditions. Distribution system efficiency shall be determined using the following equation:

Equation NG-26

$$\eta_{dist,seasonal} = 0.98\ DE_{seasonal}\ F_{equip}\ \ F_{recov}$$

where 0.98 accounts for the energy losses from heating and cooling the duct thermal mass.

NG.4.6 Hourly Distribution System Efficiency

The hourly duct efficiency shall be calculated for each hour using the following equation:

Equation NG-27

$$\eta_{\mathrm{dist,hr}} = \frac{\eta_{dist,seasonal}}{\eta_{adj,hr}}\ ,\ \eta_{\mathrm{dist,hr}} \le 1$$

where the hourly efficiency is calculated from the seasonal efficiency and an hourly efficiency adjustment factor. The hourly distribution efficiency shall be less than or equal to 1.0. The hourly duct efficiency adjustment factor shall be calculated from the following equation:

Equation NG-28

$$\eta_{adj,hr} = 1 + \mathrm{C_{DT}} \times \left(\Delta \mathrm{T_{sol,hr}} - \Delta \mathrm{T_{sol,season}}\right)$$

where the hourly efficiency adjustment factor is calculated from the difference between the hourly roof sol-air temperature and the hourly indoor temperature; the difference between the seasonal average difference between the roof sol-air temperature and the indoor temperature; and a constant derived from regression analysis.

The hourly difference between the roof sol-air temperature and the indoor temperature shall be calculated from the following equation:

Equation NG-29

$$\Delta \mathrm{T_{sol,hr}} = \mathrm{T_{solair,hr}} - \mathrm{T_{in,hr}}$$

The seasonal difference between the roof sol-air temperature and the indoor temperature shall be a load-weighted average of the hourly roof sol-air temperature and the indoor temperature, and shall be calculated from the following equation:

Equation NG-30

$$\Delta \mathrm{T_{sol,season}} = \frac{\sum_{season} (\mathrm{T_{solair,hr}} - \mathrm{T_{in,hr}})\mathrm{E_{hr}}}{\sum_{\mathrm{season}} \mathrm{E_{hr}}}$$

The hourly roof sol-air temperature is a function of the hourly ambient temperature, hourly horizontal solar radiation and the roof surface absorptance; and shall be calculated from the following equation:

Equation NG-31

$$T_{solair,hr} = T_{amb,hr} + \left(\frac{\alpha}{h_o}\right) I_{hor,hr} - \Delta T_{sky}$$

The hourly efficiency adjustment factor regression coefficient shall be calculated from the following equation:

Equation NG-32

$$C_{DT} = C_0 + {C_R}/{R_s} + C_L Q_{total,25} \text{ ; } C_{DT,cooling} \geq 0.0; \; C_{DT,heating} \leq 0.0$$

where coefficients C_o, C_R, and C_L shall be taken from Table NG-3 according to the season (heating or cooling), and the roof type for ducts in the buffer space (Standard or Cool roof) or duct location (if outdoors). The calculated value of C_{DT} for cooling shall be greater than or equal to zero, and the calculated value of C_{DT} for heating shall be less than or equal to zero.

NG.4.6.3 Hourly Efficiency Adjustment Regression Coefficients

Table NG-4 Coefficients

	Cooling			Heating		
	Standard roof	Cool roof	Outdoors	Standard roof	Cool roof	Outdoors
Co	0.000486	0.000538	-0.002763	-0.000430	-0.000418	0.000677
CR	0.002810	0.003207	0.008702	-0.003978	-0.003659	-0.002614
CL	0.002143	0.003386	0.031009	-0.012079	-0.011277	-0.012190

ACCEPTANCE FORMS

MECHANICAL

- MECH-1-A Certificate of Acceptance
- MECH-5-A Air Distribution Acceptance

2005 CERTIFICATE OF ACCEPTANCE (Part 1 of 3) MECH-1-A

PROJECT NAME		DATE
PROJECT ADDRESS		
TESTING AUTHORITY	TELEPHONE	Checked by/Date Enforcement Agency Use

GENERAL INFORMATION

DATE OF BLDG. PERMIT	PERMIT #	BLDG. CONDITIONED FLOOR AREA	CLIMATE ZONE
BUILDING TYPE	☐ NONRESIDENTIAL	☐ HIGH RISE RESIDENTIAL	☐ HOTEL/MOTEL GUEST ROOM
PHASE OF CONSTRUCTION	☐ NEW CONSTRUCTION	☐ ADDITION ☐ ALTERATION	☐ UNCONDITIONED

STATEMENT OF ACCEPTANCE

This Certificate of Acceptance summarizes the results of the acceptance tests related to building mechanical requirements per Title 24, Part 6. (Sections 10-103.b, 121.f, 122.h, 125.a, 125.b, 125.c, 125.c.5, 125.d)

Please check one:

☐ I hereby affirm that I am eligible under the provisions of Division 3 of the Business and Professions Code to sign this document as the person responsible for it's preparation; and that I am licensed in the State of California as a civil engineer or mechanical engineer, or I am a licensed architect.

☐ I affirm that I am eligible under the exemption to Division 3 of the Business and Professions Code by Section 5537.2 or 6737.3 to sign this document as the person responsible for its preparation; and that I am a licensed contractor performing this work.

☐ I affirm that I am eligible under the exemption to Division 3 of the business and Professions Code to sign this document because it pertains to a structure or type of work described pursuant to Business and Professions Code sections 5537, 5538, and 6737.1.

(These sections of the Business and Professions Code are printed in full in the Nonresidential Manual.)

TESTING AUTHORITY - NAME	SIGNATURE	DATE	LIC.#

INSTRUCTIONS TO APPLICANT

For Detailed instructions on the use of this and all Energy efficiency Standards acceptance forms, please refer to the Nonresidential Manual published by the California Energy Commission.

Part 1 of 3 - Statement of Acceptance
Part 2 of 3 - Summary of Acceptance Tests
Part 3 of 3 - Summary of Acceptance Testing Results

2005 CERTIFICATE OF ACCEPTANCE (Part 2 of 3) MECH-1-A

PROJECT NAME	DATE

SUMMARY OF ACCEPTANCE TESTS

SYSTEM ACCEPTANCE DOCUMENT(Form __ of __)	TESTING AUTHORITY	DATE OF TEST	PASS / FAIL	NOTES Bldg. Dept.

NOTE: Use additional sheets as necessary

2005 CERTIFICATE OF ACCEPTANCE (Part 3 of 3) MECH-1-A

PROJECT NAME	DATE

SUMMARY OF ACCEPTANCE TESTING RESULTS

Certified	N / A	Testing Authority Certifies That:
Air Distribution Systems		
☐	☐	The air distribution ducts and plenums meet the requirements of Section 124(a) through Section 124(g).
☐	☐	The air distribution ducts meet the requirements of Section 144(k).
Variable Air Volume Systems		
☐	☐	The fans meet the requirements of Section 144.c.2.
☐	☐	The variable air volume systems installed to comply Section 141 with individual VAV fans of motors 10 horsepower or larger shall comply with Section 144.c.2.B.
Hydronic System Controls		
☐	☐	The fans meet the requirements of Section 144(i).
☐	☐	Hydronic systems installed to comply to Section 141 shall be certified to meet requirements of each of Sections 144.i.1 through 144.i.6.
Economizer		
☐	☐	The economizers meet the requirements of Section 144.e1, 2, and 3.

2005 ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE MECH-5-A

NJ.5.1Air Distribution Acceptance Document Part 1 of 3

PROJECT NAME	DATE	TELEPHONE
PROJECT ADDRESS		
TESTING AUTHORITY		
AIR DISTRIBUTOR NAME / DESIGNATION	PERMIT NUMBER	Checked by/Date Enforcement Agency Use

Intent:	New single zone supply ductwork shall not exceed a 6% leakage rate per §144(k) or §149Di, existing single zone ductwork shall not exceed 15% leakage or other compliance path per §149Dii or §149E.

Construction Inspection

1 Scope of test – New Buildings – this test required on New Buildings only if all checkboxes 1(a) through 1(c) are checked

Existing Buildings – this test required if 1(a) through 1(d) are checked

Ductwork conforms to the following (note if any of these are not checked, then this test is not required):

☐	1a) Connected to a constant volume, single zone air conditioners, heat pumps, or furnaces
☐	1b) Serves less than 5000 square feet of floor area
☐	1c) Has more than 25% duct surface area located in one or more of the following spaces
	- Outdoors
	- A space directly under a roof where the U-factor of the roof is greater than U-factor of the ceiling
	- A space directly under a roof with fixed vents or openings to the outside or unconditioned spaces
	- An unconditioned crawlspace
☐	- Other unconditioned spaces 1d) A duct is extended or any of the following replaced: air handler, outdoor condensing unit of a split system, cooling or heating coil, or the furnace heat exchanger.

2 Instrumentation to perform test includes:

a. Fan flowmeter, manometer (pressure meter)

3 Material and Installation. Complying new duct systems shall have a checked box for all of the following categories a through f.

a. Choice of drawbands (check one of the following)

☐	Stainless steel worm-drive hose clamps
☐	UV-resistant nylon duct ties

☐	b. Flexible ducts are not constricted in any way
☐	c. Duct leakage tests performed before access to ductwork and connections are blocked
☐	d. Joints and seams are not sealed with cloth back rubber adhesive tape unless used in combination with Mastic and drawbands
☐	e. Duct R-values are verified R-8 per 124(a)
☐	f. Ductwork located outdoors has insulation that is protected from damage and suitable for outdoor service

Certification Statement

I certify that all statements are true on this MECH-5-A form including the PASS/FAIL Evaluation. I affirm I am eligible to sign this form under the provisions described in the Statement of Acceptance on form MECH-1-A

Name:		
Company:		
Signature:		Date:
License:		Expires:

INSTALLER CERTIFICATION — Part 2 of 3 — MECH-5-A

PROJECT NAME	DATE
SITE ADDRESS	PERMIT NUMBER

COPY TO: Building Department, Builder, Building Owner at Occupancy, HERS Provider

VERIFIED DUCT TIGHTNESS BY INSTALLER

The installing contractor must pressure test every new HVAC systems that meet the requirements of Section 144(k) and every retrofit to existing HVAC systems that meet the requirements of section 149 D or E (see Scope of Test under Construction Inspection)

RATED FAN FLOW (applies to all systems)		Measured Values	
1	Cooling capacity or for heating only units heating capacity		
	a) Cooling capacity (for all units but heating only units) in tons		
	b) Heating capacity (for heating only units) kBtu/h		
2	Fan flow calculation a) Cooling capacity in tons [_____(**Line # 1a**) x 400 cfm/ton] b) Heating only cap. kBtu/h [_____(**Line # 1b**) x (21.7 cfm/kBtu/h)]		
3	**Total calculated supply fan flow 2(a) or 2(b) cfm**		

NEW CONSTRUCTION OR ENTIRE NEW DUCT SYSTEM ALTERATION:			
	Duct Pressurization Test Results (CFM @ 25 Pa)		
4	Enter Tested Leakage Flow in CFM:		✓ ✓
5	Pass if Leakage Percentage ≤ 6%: [_____(**Line # 4**) /_____(**Line # 3**)] x 100	%	☐ Pass ☐ Fail
ALTERATIONS: Pre-existing Duct System with Duct Alteration and/or HVAC Equipment Change-Out			
6	Enter Tested Leakage Flow in CFM: **Pre-Test** of Existing Duct System Prior to Duct System Alteration and/or Equipment Change-Out.		
7	Enter Tested Leakage Flow in CFM: **Final Test** of New Duct System or Altered Duct System for Duct System Alteration and/or Equipment Change-Out.		
TEST OR VERIFICATION STANDARDS: For Altered Duct System and/or HVAC Equipment Change-Out Use one of the following Three Tests or Verification Standards for compliance:			
			✓ ✓
8	Pass if Leakage Percentage ≤ 15% [_____**(Line # 7)** / _____**(Line # 3)**] x 100	% 	☐ Pass ☐ Fail
9	Pass if Leakage Reduction Percentage ≥ 60% Leakage reduction = [1 - [_____**(Line#7)** / _____**(Line#6)**]} x 100	% 	☐ Pass ☐ Fail
10	Pass if all Accessible Leaks are sealed as confirmed by Visual Inspection and Verification by HERS rater (sampling rate 100%)		☐ Pass ☐ Fail
	Pass if One of Lines #8 through # 10 pass		☐ Pass ☐ Fail

INSTALLER COMPLIANCE STATEMENT

The building was: ✓ ☐ Tested at Final ☐ Tested at Rough-in

✓ ☐ I, the undersigned, verify that the above diagnostic test results and the work I performed associated with the test(s) is in conformance with the requirements for compliance credit. I, the undersigned, also certify that the newly installed or retrofit Air-Distribution System Ducts, Plenums and Fans comply with Mandatory requirements specified in Section 124 of the 2005 Building Energy Efficiency Standards.

Name:			
Company:			
Signature:		Date:	
License:		Expires:	

INSTALLER CERTIFICATION Part 3 of 3 MECH-5-A

HERS Rater: Telephone:	Sample Group Number:
Certifying Signature:	Sample building Number:
Firm:	HERS Provider:
Copies to: Builder, Building Owner at Occupancy, Building Department (wet signature), HERS Provider	

For new buildings the HERS rater must test and field verify the first individual single zone package space conditioning equipment unit of each building. After the first unit passes the builder shall identify a group of up to seven package units in the building from which one sample will be selected for testing. If this first sampled unit fails the HERS rater must pick another package unit from the group for testing. If the second unit in the group does not pass the HERS rater must test all package units in the group.

For existing buildings the HERS rater must pressure test one out of every seven units a contractor changes. Same rules apply for sampling above.

This page must be filled out by the HERS rater for all tested and sampled buildings. If the installer has not tested every system and provided a MECH-5-A to the HERS rater sampling must not occur.

The unit was: ✓ ☐ Tested ✓ ☐ Approved as part of sample testing but was not tested

As the HERS rater providing diagnostic testing and field verification, I certify that the building identified on this form complies with the diagnostic tested compliance requirements as checked ✓ on this form. The HERS rater must verify the distribution system on every new TESTED system to make sure that it is fully ducted and correct tape is used before a MECH-5-A may be released.

☐ The installer has provided a completed MECH-5-A for every system in the group
☐ New distribution systems are fully ducted (i.e., does not use building cavities as plenums or platform returns in lieu of ducts).
☐ In new duct systems, where cloth backed, rubber adhesive duct tape is installed, mastic and draw bands are used in combination with cloth backed, rubber adhesive duct tape to seal leaks at duct connections.

	RATED FAN FLOW (applies to all systems)	Measured Values	
1	Cooling capacity or for heating only units heating capacity		
	a) Cooling capacity (for all units but heating only units) [_____ tons x 400 cfm/ton]		
	b) Heating capacity (for heating only units) [_____ kBtuh x 21.7 cfm/kBtuh]		
2	**Total calculated supply fan flow 1(a) or 1(b) cfm**		
	NEW CONSTRUCTION OR ENTIRE NEW DUCT SYSTEM ALTERATION:		
3	Duct Pressurization Test Results (CFM @ 25 Pa) Enter Tested Leakage Flow in CFM:		✓ ✓
4	Pass if Leakage Percentage ☐ 6%: [_____(**Line # 3**) / _____(**Line # 2**)] x 100	%	☐ Pass ☐ Fail
	ALTERATIONS: Pre-existing Duct System with Duct Alteration and/or HVAC Equipment Change-Out		
5	Enter Tested Leakage Flow in CFM: **Final Test** of New Duct System or Altered Duct System for Duct System Alteration and/or Equipment Change-Out.		
	TEST OR VERIFICATION STANDARDS: For Altered Duct System and/or HVAC Equipment Change-Out, Use one of the following Three Tests or Verification Standards for compliance:		
6	Pass if Leakage Percentage ☐ 15% [_____**(Line # 5)** / _____**(Line # 2)**] x 100	%	☐ Pass ☐ Fail
7	For systems certified by the installer as reducing leakage, pass if Leakage Reduction ☐ 60%. $\text{LeakageReduction} = 1 - \frac{\text{(Line\#5 HERS Tested Leakage)}}{\text{(Line\#6 Installer's Certified Pre-Test Leakage)}}$] x 100	%	☐ Pass ☐ Fail
8	Pass if all Accessible Leaks are sealed as confirmed by Visual Inspection and Verification by HERS rater (sampling rate 100%)		☐ Pass ☐ Fail
	Pass if One of Lines # 6 through # 8 pass		☐ Pass ☐ Fail

TITLE 20 - CALIFORNIA HOME ENERGY RATING SYSTEM REGULATIONS

CALIFORNIA CODE OF REGULATIONS
TITLE 20
Chapter 4, Article 8, Sections 1670 - 1675

CALIFORNIA HOME ENERGY RATING SYSTEM PROGRAM

Approved Final Text

1670. Scope.

These regulations establish the California Home Energy Rating System Program pursuant to Public Resources Code Section 25942, including procedures for the training and certification of raters, and a certification program for home energy rating system organizations (herein referred to as providers) and for home energy rating services (herein referred to as rating systems). These regulations apply only to field verification and diagnostic testing services pursuant to Chapter 7 of the ACM Manual for demonstrating compliance with Title 24 building energy performance standards. Regulations for other home energy rating services will be addressed in a subsequent rulemaking proceeding. Until the subsequent rulemaking is concluded, home energy rating system services other than field verification and diagnostic testing are not required to be certified.

NOTE: Authority: Public Resources Code Sections 25942 and 25213.

Reference: Public Resources Code Sections 25942 and 25213.

1671. Definitions.

For the purposes of these regulations, the following definitions shall apply:

ACM Manual means the *Nonresidential Alternative Calculation Method Approval Manual* (Energy Commission Publication No P400-03-004) adopted in Section 10-109(b)(2) of Title 24, Part 1 of the California Code of Regulations.

Certified, as to a provider and rating system, means having successfully completed the certification requirements as specified by Section 1674.

Commission means the State of California Energy Resources Conservation and Development Commission, commonly known as the California Energy Commission.

Financial Interest means an ownership interest, debt agreement, or employer/employee relationship. Financial interest does not include ownership of less than 5% of the outstanding equity securities of a publicly traded corporation.

Independent Entity means having no financial interest in, and not advocating or recommending the use of any product or service as a means of gaining increased business with, firms or persons specified in Section 1673(i).

NOTE: The definitions of "independent entity" and "financial interest," together with Section 1673(i), prohibit conflicts of interest between providers and raters, or between providers/raters and builders/subcontractors.

Provider means an organization that administers a home energy rating system in compliance with these regulations (referred to as a "home energy rating service organization" in Section 25942 of the Public Resources Code).

Rater means a person performing the site inspection and data collection required to produce a home energy rating or the field verification and diagnostic testing required for demonstrating compliance with the Title 24 energy performance standards, who is listed on a registry in compliance with Section 1673(c).

Rating means a representation on a 0 to 100 scale of the annual source energy efficiency of a home, as specified in Section 1672(c).

Rating System means the materials, analytical tools, diagnostic tools and procedures to produce home energy ratings and provide home energy rating and field verification and diagnostic testing services (referred to as "home energy rating services" in Section 25942 of the Public Resources Code).

Service Water Heating means service water heating as defined in Section 101(b) of Title 24, Part 6 of the California Code of Regulations.

Source Energy means source energy as defined in Section 101(b) and calculated as specified in Section 102 of Title 24, Part 6 of the California Code of Regulations.

NOTE: Authority: Public Resources Code Sections 25942 and 25213.

Reference: Public Resources Code Sections 25942 and 25213.

1672. Requirements for Rating Systems.

a. Rating Site Inspections and Diagnostic Testing. Each rating shall be based on a site inspection of the home, and diagnostic testing as specified by the rating system. Each rating system shall have documented procedures for site inspection and diagnostic testing of rated homes.

(b) Energy Uses Rated. Each rating system shall rate the total combined energy efficiency of the following energy uses of each home rated:

(1) space heating;

(2) space cooling; and

(3) service hot water.

(c) Rating Scale. Each rating system shall rate the annual source energy efficiency of homes on a scale of 0 to 100. The rating shall be for the combined total of the three energy uses described in Section 1672(b).

(d) Field Verification and Diagnostic Testing. The provider and rater shall provide field verification and diagnostic testing of energy efficiency improvements as a condition for those improvements to qualify for Title 24 building energy performance standards compliance credit, as required by Chapter 7, Appendix F, and Sections 3.8.3 and 3.9 of the ACM Manual. Providers and raters shall not knowingly provide untrue, inaccurate or incomplete field verification or diagnostic testing information or report field verification or test results that were not conducted in compliance with these regulations. Providers and raters shall not knowingly accept payment or consideration in exchange for reporting a rating or field verification and diagnostic test result that was not in fact conducted and reported in compliance with these regulations.

NOTE: Authority: Public Resources Code Sections 25942 and 25213.

Reference: Public Resources Code Sections 25942 and 25213.

1673. Requirements for Providers.

(a) Training and Certification Procedures for Raters. Each provider shall conduct the following rater training and certification procedures.

(1) Each provider's training program shall include classroom and field training for rater applicants in analysis, theory and practical application in at least the following areas:

(A) home energy consumption and efficiency data collection, organization and analysis;

(B) principles of heat transfer;

(C) building energy feature design and construction practice, including construction quality assurance and "house as a system" concepts;

(D) safety practices relevant to home energy auditing procedures and equipment; (E) home energy audit procedures;

(F) energy efficiency effects of building site characteristics;

(G) types and characteristics of space heating, space cooling, service hot water and hard wired lighting systems;

(H) mathematical calculations necessary to utilize the rating system;

(I) the function and proper use of diagnostic devices including but not necessarily limited to: duct leakage testing equipment, blower doors and air flow and pressure measurement devices;

(J) construction types, equipment types and their associated energy efficiency ramifications;

(K) field verification and diagnostic testing requirements of Chapter 7, Appendix F, and Sections 3.8.3 and 3.9 of the ACM Manual; and

(L) California Home Energy Rating System Program requirements specified in these regulations.

(2) The training shall include thorough instruction in the use of the provider's rating system.

(3) The training shall require rater applicants to satisfactorily perform field verification and diagnostic testing for at least two homes in the presence and under the direct supervision of the provider's trainer. The provider shall review and approve this field verification and diagnostic testing for accuracy and completeness.

(4) The provider shall require each rater applicant to take a written and practical test that demonstrates his or her competence in all subjects specified in Section 1673(a)(1). The provider shall retain all results of these tests for five years from the date of the test.

(5) Each provider may establish a Commission-approved challenge test that evaluates competence in each area addressed by the provider's training program. If a rater applicant successfully passes this challenge test, the provider may waive the classroom training requirement and the written and practical test requirements for that applicant. An applicant who passes this challenge test must also successfully meet the requirements specified in Section 1673(a)(3).

(b) Rater Agreements. As a condition of rater registry under Section 1673(c), each provider shall ensure that a rater applicant who has met the requirements of Section 1673(a) has entered into an agreement with the provider to provide home energy rating and field verification and diagnostic services in compliance with these regulations. The agreement shall require raters to:

(1) provide home energy rating and field verification services in compliance with these regulations;

(2) provide true, accurate, and complete ratings, field verification and diagnostic testing; and

(3) comply with the conflict of interest requirements as specified in Section 1673(i).

(c) Rater Registry. As a condition of rater registry, each provider shall certify to the Commission that a rater applicant has met the requirements of Section 1673(a) and entered into an agreement meeting the requirements of Section 1673(b). The provider shall maintain a registry of all raters who meet these requirements, provide an electronic copy of the registry to the Commission, and make that registry available in printed or electronic form upon written request.

(d) Field Verification and Diagnostic Testing Data Collection. Each provider shall collect and maintain for a period of five years, the following information for each home for which field verification and diagnostic testing service is provided:

(1) *Certificates of Field Verification and Diagnostic Testing*;

(2) *Certificates of Compliance;*

(3) *Installation Certificates*; and

(4) other reports made pursuant to Chapter 7 of the ACM Manual.

Alternatively, the information contained in these documents may be collected and stored electronically as long as all of the content and certification signatures from the specified documents are retained.

(e) Field Verification and Diagnostic Testing Evaluation. Providers shall maintain a database of the information specified in Section 1673(d) for a minimum 10% random sample of the homes actually field verified and diagnostically tested annually, or 500 such homes annually, whichever is less. Each provider shall provide this information annually in electronic form to the Commission for evaluating the effectiveness of field verification and diagnostic testing. To the extent that the Commission makes this information public, it will do so only in aggregated form. All of this information shall be organized according to climate zones as defined in Section 101(b) of Title 24, Part 6 of the California Code of Regulations.

(f) Data Submittal. Upon the Commission's request, but not more frequently than annually, a provider shall submit to the Commission the total of the number of homes for which field verification and diagnostic testing services were provided since the last data submittal, and a report of the following information for each home for which field verification and diagnostic testing service was provided:

(1) the energy efficiency improvements field verified and diagnostic tested;

(2) whether or not the builder chose to include the home in a sample for field verification and diagnostic testing as specified in Section 7.4 of the ACM Manual;

(3) whether or not initial field verification and testing as specified in Section 7.4.1 of the ACM Manual was conducted on the home;

(4) whether or not the home in a sample was actually selected and field verified and diagnostically tested as specified in Section 7.4.2 of the ACM Manual;

(5) whether or not the home in a sample was actually selected for resampling and field verified and diagnostically tested after a sampling failure was found in the sample as specified in Section 7.4.3 of the ACM Manual;

(6) whether or not the home in a sample was field verified and diagnostically tested and corrective action was taken after a resampling failure was found in the sample as specified in Section 7.4.3 of the ACM Manual;

(7) whether or not the homeowner declined to have field verification, diagnostic testing and corrective action taken after occupancy as specified in Section 7.4.3 of the ACM Manual.

All of this information shall be organized according to climate zones as defined in Section 101(b) of Title 24, Part 6 of the California Code of Regulations. To the extent the Commission makes this information public, it will do so only in an aggregated form.

(g) Training Materials Retention. Each provider shall retain for at least five years after the last date they are used at least one copy of all materials used to train raters.

(h) Quality Assurance. Each provider shall have a quality assurance program that provides for at least the following:

(1) Initial review. The provider shall review and approve for accuracy and completeness the field verification and diagnostic testing documentation for at least the first five homes which a rater performs after completion of the requirements specified in Section 1673(a)(1), (2) and (3), not including those homes field verified and diagnostically tested under the provider's direct supervision as specified in Section 1673(a)(3).

(2) Field checks of raters. For each rater, the provider shall annually evaluate the greater of one home or one percent of the rater's annual total of homes for which field verification and diagnostic testing services were provided. The provider shall independently repeat the field verification and diagnostic testing to check whether field verification and diagnostic testing was accurately completed by the rater, and determine whether information was completely collected and reported as required by Chapter 7 of the ACM Manual.

(3) Complaint response system. Each provider shall have a system for receiving complaints. The provider shall respond to and resolve complaints related to ratings and field verification and diagnostic testing services and reports. Providers shall ensure that raters inform purchasers and recipients of ratings and field verifications and diagnostic testing services about the complaint system. Each provider shall retain all records of complaints received and responses to complaints for five years after the date the complaint is presented to the provider.

(i) Conflict of Interest.

(1) Providers shall be independent entities from raters who provide field verification and diagnostic testing.

(2) Providers and raters shall be independent entities from the builder and from the subcontractor installer of energy efficiency improvements field verified or diagnostically tested.

NOTE: Authority: Public Resources Code Sections 25942 and 25213.

Reference: Public Resources Code Sections 25942 and 25213.

1674. Certification of Providers and Rating Systems.

(a) Application. A person or entity wishing to be certified as a provider and wishing to have a rating system certified shall submit four copies of an application to the Commission. The application shall contain:

(1) a complete copy of all field verification and diagnostic testing procedures, manuals, handbooks, rating system descriptions, and training materials;

(2) a detailed explanation of how the rating system meets each requirement of Section 1672;

(3) a detailed explanation of how the provider meets each requirement of Section 1673;

(4) the name, address, and telephone number of the provider and a statement of where its principal place of business is and where and upon whom service of legal process can be made;

(5) upon Commission request, if the provider is a corporation, a copy of the articles of incorporation and the current by-laws;

(6) if the provider is a partnership, the names, addresses, telephone numbers, and partnership status (for example, general, managing) of all the partners, and a copy of the current partnership agreement;

(7) the names, addresses, telephone numbers, and business relationships of all the provider's owners, parents, subsidiaries, and affiliates;

(8) a statement that ratings are accurate, consistent and uniform, utility bill estimates are reasonable, and recommendations on cost-effective energy efficiency improvement measures are reliable;

(9) a statement that the provider understands and will not knowingly fail to comply with the requirements of these regulations; and

(10) a statement under penalty of perjury that all statements in the application are true, provided in the form specified by Section 2015.5 of the Code of Civil Procedure.

(b) Confidentiality of Information. Any provider who submits the required application information and wishes to have that information treated as confidential in order to limit its disclosure shall, at the time of submitting the information, apply for a confidential designation as specified in Section 2505 of Title 20 of the California Code of Regulations.

(c) Commission Consideration.

(1) The Commission's Executive Director may request additional information from the applicant necessary to evaluate the application.

(2) The Executive Director shall provide a copy of its evaluation to interested persons. The Executive Director may convene a workshop to receive comments from interested persons.

(4) Within 90 days of receiving the complete application, the Executive Director shall send to the Commission and to the applicant a written recommendation that the Commission certify the provider and its rating system or deny that certification.

(5) The Executive Director shall recommend certifying the provider and rating system if it finds the following:

(A) the rating system meets all of the requirements of Section 1672; and

(B) the provider meets all of the requirements of Section 1673.

(6) The Commission shall act on the recommendation at its next regularly scheduled Business Meeting that is at least fifteen days after the date that the recommendation was mailed to the applicant.

(7) The Commission shall certify the proposed provider and rating system if it confirms the Executive Director's findings in Section 1674(c)(5).

(8) Upon certification the Commission shall assign the provider a three-digit identification number.

(d) Re-certification. A certified provider shall notify the Commission whenever any change occurs in any of the information, documentation, or materials, the provider submitted to the Commission under Section 1674(a), and shall submit the changed information to the Commission. Where this changed information could affect the provider's compliance with these regulations, the Commission may require that the provider and the rating system be re-certified under the process described in Section 1674. The Executive Director may waive re-certification for non-substantive changes. The Commission may also require that providers and rating systems be re-certified if the requirements of these regulations are amended or modified.

NOTE: Authority: Public Resources Code Sections 25942 and 25213.

Reference: Public Resources Code Sections 25942 and 25213.

1675. Review by the Commission.

(a) Annual Review. The Commission may annually review the performance of providers certified under Section 1674 to determine whether the providers comply with the requirements

of these regulations. This review may include interviewing recipients of ratings and field verification and diagnostic testing services and reports on a voluntary basis.

(b) Complaint Proceedings. Any person or entity may file a complaint concerning any violation of these regulations as provided for in Section 1230 et. seq. of Title 20 of the California Code of Regulations. The Commission may, for good cause, conduct an investigation and, if necessary, hearing, under the procedures established in Section 1230 et. seq. of Title 20 of the California Code of Regulations.

Each provider shall provide all information requested by the Commission regarding any annual review or complaint proceeding.

(c) Commission Determination. If the Commission determines there is a violation of these regulations or that a provider is no longer providing rating, field verification and diagnostic testing services, the Commission may revoke the certification of the provider pursuant to Section 1230 et. seq. of Title 20 of the California Code of Regulations.

NOTE: Authority: Public Resources Code Sections 25942 and 25213.

Reference: Public Resources Code Sections 25942 and 25213.